ELECTRICAL REVIEW

[ILLUSTRATED.]

A WEEKLY JOURNAL OF

ELECTRIC LIGHT, TELEPHONE TELEGRAPH AND SCIENTIFIC PROGRESS.

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Engine and Dynamo for the Steamship "Ohio" Installation.

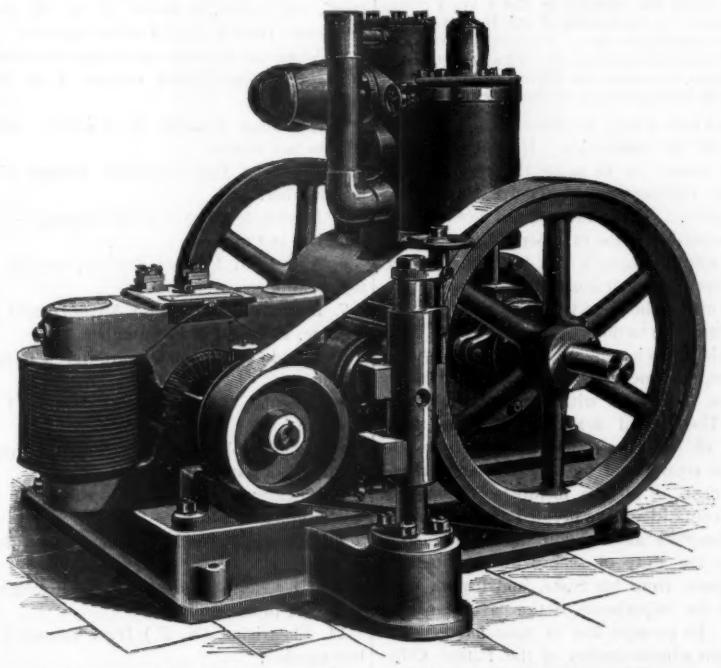
The lighting of the "Ohio" throughout by electricity has been carried out by Messrs. Muir, Mavor & Coulson, of Glasgow. The engine and dynamo are mounted on the same bed plate, with their shafts parallel, while between the engine fly wheel and the dynamo pulley is a friction pulley fitted with a vertical screw adjustment. This friction pulley is built up of leather discs upon a cast-iron sleeve, the leather discs being wetted and then clamped by means of bolts passing through them between a flange on one side and a wrought-iron ring on the other. The surface is turned up true after the leather has thoroughly dried. The edge of the leather is thus presented to the driving and driven pulleys. The driving strap is of gutta-percha, and may be kept very tight, as the strain upon the bearings is completely relieved by the adjustment of the friction pulley, which also assists in the transmission of power. This gear has proved itself highly satisfactory, running remarkably free from noise or vibration, and with perfectly cool bearings when giving its maximum output of 165 lamps of 16 c. p. each. The speed of the engine is 400 revolutions, and that of the dynamo 1,200 revolutions per minute, the diameter of the friction pulley being 8in. The e. m. f. at the dynamo terminal is 110 volts. The system of wiring deserves a passing notice. The conductors throughout are in substantial teakwood casing, and at every junction of a sub-main with a main, or branch with a main or sub main, double pole fuses are used. These fuses are mounted on slate bases fixed on the casing with a slate partition between the positive and negative, and the whole covered with an asbestos-lined brass cap. The advantage of double pole fuses for testing or for alterations or additions will be at once apparent, more especially on such ships as the "Ohio," where the 'tween decks are alternately used for passengers and for cargo. The safety fuses are also double pole, and are enclosed in cast-iron water-tight boxes, with a removable brass cover which is screwed down on a red lead joint. The branch wires pass through water-tight stuffing boxes. Lanterns containing four lamps of 32 c.p. each are provided for working cargo. Attachments are fixed at all the hatches, so that the lanterns with 40 feet of flexible cable may be used in any part of the ship, or over the side when in dry dock. The SS. "Ohio" was built in this country but has recently been refitted in Glasgow.—*Industries.*

The New Phœnix Dynamo.

Our contemporary, *Industries*, London, says that the present tendency, as regards the construction of field magnets for dynamo machines, seems to be in favor of the single horseshoe type. Several makers, who began by designing double horseshoe machines, have given up their original pattern, and are using single horseshoe magnets, which have the advantage of requiring less exciting energy, and giving therefore a slightly increased efficiency. In addition to this advantage, the amount of wire on the field is also reduced, and the cost of production slightly less, as compared with the other type; but they have the drawback of being rather heavier than double horseshoe machines. With a view to reduce the weight, and secure some other advantages, Messrs. Paterson and Cooper have lately made a new type of their Phœnix machine, wich we illustrate in the engraving on page 3. The magnetic system consists of a single horseshoe in one solid forging, by which means the magnetic resistance of joints is avoided. In order to reduce the weight, the usual bed plate and standards for the support of bearings have been omitted, the bearings being placed in gun metal bridge pieces bolted to the polar extensions of the magnet limbs, as shown. To secure sufficient stability, two cast-iron angle brackets are bolted to the yoke of the magnet, and these are provided with holes for the foundation bolts.

The machine is designed for an output of 100 amperes at 250 volts pressure, when driven at 700 revolutions per minute. The total weight is 28cwt., being at the rate of 1 lb. of material for every 8 watts developed in the external circuit. The following are some of the constructive data of the machine: External diameter of armature core, 13¾in.; internal diameter of armature core, 8in.; length of armature core, 12in.; cross section of magnets, 12in. by 8in.; net sectional area of iron in armature, allowing for insulation, 30 sq. in.; sectional area of iron in field, allowing for rounded corners 95 sq. in.; diameter of polar cavity, 15in The armature is wound with 360 turns of .150 in. square wire in two layers. The field is shunt wound, each link containing 3,540 turns of .062 wire, and the total resistance is 83 ohms. The radiating surface of both magnet limbs is 1,200 sq. in., and the energy used up in exciting is 750 watts, the ratio of cooling surface being, therefore, 1.6 sq. in. per watt. The internal electromotive force is 258 volts, and with a shunt current of about 3 amperes the electrical efficiency is $\frac{250 \times 100}{258 \times 103} = 94$ per cent.

From the above data we find that the total intensity of the field is about 6,200,000 c.g.s. units, that the useful induction through the armature is 16,000, and the induction through the field 10,100 lines per square centimeter. The peripheral speed of the armature core is 2,530ft. per minute, and the total length of conductor wound on the armature is 11,200in., being at the rate of 45in. per volt in the external circuit. For purposes of comparison, it is convenient to state the output of the machine for a peripheral speed of 3,000ft., which is a fair average in modern belt-driven dynamos, and on this basis we find that 38in. of armature conductor produce 1 volt, whilst the weight of the machine comes out at about 80lb per horse power in the external circuit.



ELECTRIC AND STEAM PLANT ON BOARD THE ENGLISH STEAMSHIP "OHIO."

The Oldest Vermont Telegrapher.

The St. Johnsbury *Republican* says that the oldest Vermont telegrapher, in length of service, has just retired. We refer to H. N. Drury, Esq., of Burlington, who has had charge of the telegraph office in that city for nearly or quite 30 years. Mr. Drury is a printer by trade and in his youth had an adventurous career at the South, publishing papers in those localities where on every publication day the editor sat down with a loaded rifle across his lap, waiting for visitors similarly armed. After a number of years of this sort of thing he determined to try a milder climate, and accepted an offer to take charge of the Burlington telegraph office, where he has ever since remained. Like most printers, he is a first-class man in every respect, and we trust that the years of his retirement will be as long and as prosperous as those of his career as manager.

*** The Buffalo Telephone Company is making a number of improvements.

ELECTRIC LIGHT AND POWER.

These Interests Represented in the Greatest Electrical Gathering ever Held.

THE SIXTH MEETING OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION PROVES A GRAND SUCCESS.

Full Report of the Interesting Proceedings and the Addresses Delivered.

PITTSBURGH SELECTED AS THE NEXT MEETING PLACE.

Excursion Down the Bay and Elaborate Banquet Tendered by the City of Boston and Thomson-Houston Co.

THE HUB EXTENDS A HEARTY WELCOME AND THE BOSTON ELECTRIC CLUB DID THE HONORS MOST AGREEABLY.

This journal, in the last issue, gave to its readers a comprehensive account of the work of the National Electric Light Association up to Wednesday evening, carrying to its many thousands of readers information eagerly sought for, a week in advance of all contemporaries. In this issue we give our full stenographic report, including the many papers presented to the association, and the discussion which followed.

The convention, as stated in our last, convened in parlors of the Parker House, Boston, at 10.15 A. M. Tuesday, August 9th. President Morrison's able opening address was followed by eloquent words of welcome from Mayor O'Brien. Mr. W. H. Harding, the new and very efficient secretary, then made his report, which showed a balance of $860 in the treasury.

The report of the Committee on Patent Legislation was presented by Mr. Arthur Steuart, of Baltimore:

REPORT OF COMMITTEE ON PATENT LEGISLATION.

At the February meeting of this association, your Legal Committee made a report in which were set out some of the present needs of the United States Patent Office, and suggested a means by which the needs might be met and the defects remedied.

The subject being one of great importance, a special committee upon Patent Legislation was appointed, consisting of Mr. J. F. Morrison, Mr. Walter C. Kerr, New York, Mr. Frank Ridlon, Mr. F. J. Sprague and Mr. Arthur Steuart, the chairman of the

Legal Committee, to further consider the questions presented, and make a full report to this convention. Your committee has given the matter careful consideration and report that they are convinced that that branch of the patent system which relates to the granting of patents is based upon a law which was formulated at a time when the mass of business to which it was applicable was one-fiftieth part of what it is at present, and that the law needs revision in the following particulars among other :

I. The statute law of the United States relative to the granting of patents has very few provisions which determine the rights of applicants. The result is that nearly all the vital questions both of law and fact by which the rights of applicants for patents are to be determined, now lie within the jurisdiction of the various branches of the Patent Office. The examiners have nearly all questions fact to determine primarily as well as many questions of law, and their jurisdiction is divided up among a number of junior examiners who are over-burdened with work. The Examiner of Interferences sits as a court to determine the question of priority between contestants for patents on the same invention. From the primary examiners cases go on appeal to a board of examiners in chief, and from them to the commissioner, and appeals from examiner of interferences go to the commissioner. The *personnel* of the office is constantly changing, the commissioners more often than others. Then, too, the persons who are appointed to the position of commissioner are generally chosen for some reason that has no connection with patent law ; so that, as a general rule, the highest appellate tribunal knows less about the law and practice of the patent office and the rules by which patent cases are to be decided than the examiner from whom the first appeal is taken. This being true, it is not surprising that the examiners pay comparatively little respect to the decisions of the commissioner, and also that one green commissioner following another in quick succession should make rulings which result in a hopeless chaos in the practice. In addition to this fact the commissioner is burdened with executive duties, which demand so much of his time, that with the greatest experience and power of work, it is impossible for him to properly consider the numerous important cases presented for his decision.

In order that the legal rights of patentees may be fully defined and secured, it is necessary that those rights should be understood and a settled method of obtaining them established ; for this reason, it is desirable that some means should be adopted to make clear and uniform the practice of the Patent Office.

All authorities seem to agree that the best method of accomplishing this result is to establish a strong court in the Patent Office that shall have jurisdiction of all legal questions arising in relation to the issuance of patents as well as all questions of fact which arise in interference proceedings, and on appeal from the examiners.

II. The work required of the examiners in the Patent Office is of such a technical nature and so important to the public, that it seems to be desirable that the Patent Office should be put on the same footing as the Army and Navy. That the examiners should be educated for the service, should receive compensation equal in corresponding positions to officers of the Army and Navy, should have the same system of admission and promotion upon the ———— and retirement on pay equal to that of those departments of the public service.

III. The Patent Office is now cramped for space, the employes are crowded into quarters half large enough for them, and the Patent Office building, built with money paid the Government by patentees, is more than half occupied by the Interior Department, which should have separate accommodations. Additional space would enable the Patent Office to have a laboratory so much needed for the demonstration of electrical and other scientific discoveries and inventions.

To accomplish these reforms the most cautious, expeditious, and at the same time intelligent way, seems to be, the creation of a commission to be appointed by the President, which shall carefully examine these and all other questions relative to the subject and report an act to Congress which will provide for their solution. We suggest the following bill, which we propose shall be submitted to Congress this winter for passage:

A BILL

CREATING A COMMISSION TO EXAMINE AND REPORT TO CONGRESS NEEDFUL REFORMS IN THE PATENT LAW.

WHEREAS, The Patent Laws of the United States are deemed to be in such a condition as to require revision, therefore,

Be it Enacted, by the Senate and House of Representatives of the United States in Congress assembled :

SEC. 1. That a Commission be and the same is hereby created, to consist of three suitable persons to be appointed by the President of the United States, who shall hold office until a final report of the Commission is submitted to and accepted by Congress, and who shall receive for their service a compensation of $5,000 each per annum.

SEC. 2. It shall be the duty of this commission to examine thoroughly the present patent laws of the United States and those of other countries, and their practical operation and effect in meeting the needs of the public, and fulfilling the purposes for which they were created. To formulate a report to be submitted to Congress, which shall set forth the results of this investigation, and their conclusion therefrom with reference to changes in or additions to the present law pertaining to patents. This report shall also contain a draft of an act which will provide for the changes found necessary by the investigations of the commission.

SEC. 3. The commission is authorized to employ such clerical force as may be necessary for the proper conduct of its work, and to incur such other expenses for stationery, printing, etc., as may be found expedient.

SEC. 4. The salaries of the members of this commission, as well as all expenses legitimately incident to its work, shall be paid from the surplus in the United States Treasury to the credit of the Patent Office. All expenditure by or for said commission, other than the salaries of the members, shall, however, be under the control of and authorized by the Secretary of the Interior.

And now a duty devolves upon the members of the association. It is one thing for your committee to make this report, but a totally different thing to have it passed by Congress. That result can, however, be accomplished if the members of the association will intelligently and faithfully support the hands of their committee by themselves, each one of them, doing the part of the work assigned him to do.

This association represents twenty-four States, and members of this association are fellow townsmen with eighty members of the House and Senate, while the members of the House and Senate from the States represented in the association are 61 per cent. of all the members of Congress. The committee have divided up the members of Congress among you, and assigned to each the duty of seeing the members of Congress from his State, and urging upon them the importance of the passage of this bill. Its passage lies in your hands. The present administration of the Patent Office has but one outcome. As the inability of the Patent Office to cope with the work of properly examining applications for patents increases, the respect paid by the courts and the public to patents will lessen, until all patents (and almost every dollar in the electric lighting business is invested under a patent) will come to be considered of no value until they have passed through the rack and fire of a legal fight, and obtained judicial construction. To avoid this contingency, your committee feel sure that you will act promptly and effectively.

The committee think it very desirable that the next meeting of the association be held in the city of Washington. The location is central, and Congress will be in session at that time. The members of Congress will have an opportunity of seeing how large and important an interest is calling upon them for action; and the members of the association can take the opportunity of waiting upon their representatives in Congress, and urging the passage of the bill we present for the appointment of the commission.

Present at the meeting of committee, July 21, 1887, at office of ELECTRICAL REVIEW, New York.

J. F. MORRISON.
FRANK RIDLON.
WALTER C. KERR.
F. J. SPRAGUE.
ARTHUR STEUART, Chairman.

I have only one word to say, in connection with a report which I shall submit in writing, of the Legal Bureau, of which I have the honor to be the custodian. The report will give a sketch of the work that is being done. A digest is in course of preparation, covering the literature of electric lighting. We have at our command at present a set of journals and books which I suppose are not to be found anywhere in this country, save in Baltimore. We believe that this analytical digest of the literature of electric lighting, which we are preparing, will be useful to the association.

REPORT OF LEGAL BUREAU.

The custodian of the Legal Bureau would report that in the near future he expects to be able to offer to the members the use of an analytical digest of patents, as well as the literature of electric lighting and subjects collateral to it, that will make it possible to determine with great accuracy as well as expedition, the exact state of the art in any department, and hence the validity and scope (as far as such can be determined in the absence of judicial determination) of any patent that may be submitted for examination. The digest will embrace all United States patents on electric lighting and collateral subjects:

English patents.

French patents as far as they can be obtained.

And the following publications:

1. American Academy of Arts and Sciences, old series, volumes 11 to 17, and new series from volume 3 to last number.

2. American Association for the Advancement of Science, from volume 1 to last number.

3. American Journal of Science, from 1819 to last number.

4. American Engineer, from volume 2 to last number.

5. Annlen de Chemié et de Physique, volume 1 to last number.

6. Associated English Society, volume 1 to last number.

7. British Association for Advancement of Science, volume 1 to last number.

8. Canada Royal Society, volume 1 to last number.

9. Canadian Science Record, volume 1 to last number.

10. Constralblatt fur Electritechnik, from volume 5 to last number.

11. ELECTRICAL REVIEW, volume 1 to last number.

12. Electrical World, volume 1 to last number.

13. Electrician (London) from November 1st, 1880, to last number.

14. Electrician (N. Y.) from volume 1 to last number.

15. Electrician and Electrical Engineer, volume 1 to last number.

16. Electriceté (L') from 1880 to last number.

17. Journal Franklin Institute, from volume 1 to last number.

18. Industrial Review, from volume 1 to last number.

19. Jahresheicht uber Chemie und Physik, from 1882 to last number.

20. Journal de l'Ecole Poletechnique, volume 1 to last number.

21. Journal de Physique, from 1872 to last number.

22. London Philosophical Magazine, from 1798 to last number.

23. Journal Royal Society, from 1830 to last number.

24. Journal Society Telegraphic Engineers, from 1883 to last number.

25. La Lumiere Electrique, from volume 3 to last number.

26. Nature (London) volume 13 to last number.

27. Comptes Rendues, volume 1 to last number.

28. Poggendoeffs Annalen, volume 1 to last number.

29. Science Record, volume 1 to last number.

30. Scientific American and Supplement, from 1879 to last number.

31. Telegraphic Journal and Electrical Review, from October, 1876, to last number.

32. Science, volume 1 to last number.

33. Zeitschleft fur Instrumenden Kunde, volume 1 to last number.

In addition to the foregoing, such books will be added as are found of value.

Respectfully,
ARTHUR STEUART,
Chairman Legal Commission, N. E. L. A.

These reports were accepted, and the following resolution, on motion of Mr. Ridlon, was adopted:

Resolved, That the report of the Committee on Patent Legislation be accepted, the committee continued, and authorized to take such steps—not involving expense to the association—as they may find necessary, to have this act passed by Congress.

Unanimously adopted.

The report of the Committee on Revision of the Constitution and By-Laws was read by the secretary, and, after some discussion, was recommitted to the committee, and Mr. S. A. Duncan added to the committee.

MR. A. V. GARRATT presented a very comprehensive report from the Wire Gauge Committee, favoring the metric system, and, after some discussion, it was made the special order for Thursday forenoon.

THE PRESIDENT: In the absence of Mr. Slattery, who was to have read a paper on electrical distribution by means of alternating currents, we will take up the partial report made by the Committee on Insulation and Construction of Plant.

MR. ROBINSON : I would like just a word here in reference to that report as a member of that committee. I have read a rough draft of the partial report the committee has made, and not being able to endorse the report before it is presented to the convention I would say that the committee as a whole have resigned from the work, and as I could not endorse what they said, I would not resign with them. Finding myself in a small minority, not even a fighting minority, I would ask you to accept my resignation.

THE PRESIDENT : Gentlemen of the association, you have the verbal resignation of Mr. Robinson before you. He begs to tender his resignation as a member of the Committee on Proper Insulation of Wires and Proper Installation and Construction of Plant. The reason he gives for that is that he is unable to subscribe his name to the contents of this partial report. Therefore, he tenders his resignation. What will you do with the resignation.

A MEMBER: I move that the resignation be accepted.

THE PRESIDENT put the question, but no one voted.

THE PRESIDENT: Gentlemen of the convention : You are here to perform whatever duty is assigned to you in the regular order of the work. No man need be ashamed to vote on anything. Every man should have an opinion of some sort, and he should be able to express that fearlessly. Again I put the question.

MR. GARRATT : We do not understand what Mr. Robinson resigns from.

THE PRESIDENT: He offers his resignation from the Committee on Proper Insulation of Wires and Proper Installation and Construction of Plant.

MR. DECAMP : Mr. Robinson is in a very awkward position. He is in so small a minority that he feels it would be presumptuous for him, I suppose, to make a report.

MR. ROBINSON : No, sir. I would like to reply to Mr. DeCamp in that matter and say that I received a rough draft of the partial report late on Monday, and therefore could only study through it hastily, and supposing they were going to make a report, until yesterday, I was totally unprepared to make any report whatever. I beg that you will accept my resignation, and let me out of the scrape.

THE PRESIDENT: I think it is only fair that the resignation be accepted or rejected. Again I place the question before you.

The motion to accept the resignation was then carried.

THE PRESIDENT: Before placing this paper in the hands of the secretary to be read, I beg to say that on a date which I am unable to find in the correspondence, this committee—either all six or one of its members, perhaps—wrote to me asking that the National Electric Light Association furnish them with a fund of $1,000 to carry on their investigations, guarantee the cost of repair to any apparatus that might be damaged in the course of their investigations—apparatus which was to be supplied to them from the University of Pennsylvania; also that an assistant be furnished at $3 a day. I laid that correspondence before the executive committee which met in Boston on June 9th. The committee found only one course open to them. The funds of this association are applied to its running expenses, with which you are all familiar. There was no such sum on hand to be turned over to the committee. Nothing more was heard from the committee until this paper, with quite a column of printed matter, was sent in on yesterday or the day before to the National Electric Light Association. Now, this paper is signed by Edward J. Houston, chairman; Wm. D. Marks, Carl Hering and M. M. Garver, and is not signed by Mr. Robinson; and the reason he gave for his resignation, independent of this paper, was that he could not subscribe to the subject matter contained in this report. Mr. Secretary, read the report.

The report was then read by the secretary.

REPORT OF THE COMMITTEE "ON PROPER INSULATION OF WIRES AND PROPER INSTALLATION AND CONSTRUCTION OF PLANTS."

The committee appointed by your honorable body hereby respectfully submit the following report:

The rapid growth of the electric lighting interests during the last decade, the large investments already made in such interests, together with the still greater growth that is probable in the near future, have strongly impressed your committee with the important nature of the work instrusted to them.

Your committee fully recognized the fact that any report to an association that represents the leading electric interests of the country, would naturally be expected to be of a thorough character; they therefore determined as far as lay in their power to spare no labor in the performance of their work.

The duties charged on the committee naturally divide themselves into two general classes, viz.:

1. The proper insulation of the wires or leading conductors.

2. The proper installation and construction of the plant as far as relates to the insulation and protection of the machines, lamps, conductors, and accessories, and to the safety of consumers, attendants and buildings.

The first branch necessitates an exhaustive and carefully planned series of practical tests as to the insulation of the leading wires; the second, the preparation of a code of rules, based on actual experience, for the general installation of the plants, both so far as concerns the insulation thereof, and for its protection, as well as that of the consumers, attendants and buildings; or, in other words, to provide for such an installation of the plant as will best ensure the protection of life and property.

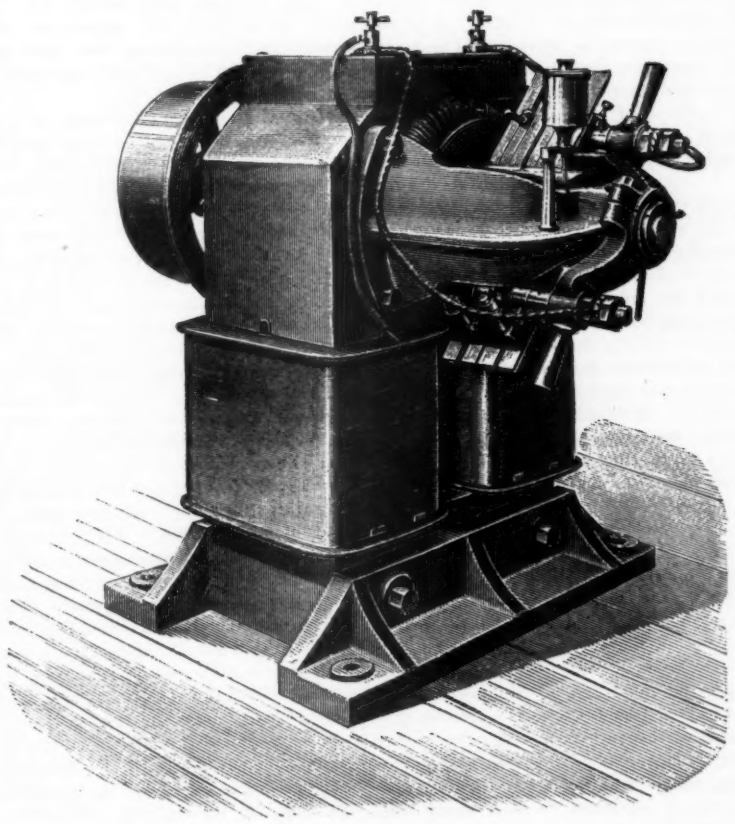
Referring to the first branch of its work, your committee appreciate the fact that a mere theoretical discussion of the subject would prove of but little value to an association composed of men practically engaged in electric lighting.

They are aware that considerable valuable data have already been accumulated concerning the high insulation required for telegraphic cables, especially submarine. They are also aware that laboratory tests have been made of ordinary electric wires. These data, however, either refer to conductors not included in the scope of your committee's investigations, or, though referring to electric light conductors, have been made under conditions that would render them but of little practical value in this connection.

Your committee therefore planned to make a careful series of practical tests under conditions as nearly as possible similar to those to which the conductors are actually subjected in existing installations.

The committee determined to limit their investigations chiefly to the leads that are ordinarily used in arc and incandescent lighting, subjecting them during such tests, as nearly as possible, to the various disturbing or other conditions that are met with in actual practice. They hoped by these means not only to obtain data by which the relative commercial efficiency of the different wires in the market could be determined, but also possibly to lead to the determination of the best conditions to be observed in the manufacture of insulated wire, in order to ensure the production of the most serviceable material.

Tests, such as those contemplated, and of necessity required by the character of the work, not only called for excessive labors on a part of the committee, but also for the use



THE PHŒNIX DYNAMO.

of specially designed apparatus. Although the committee had the use of the well-equipped electrical laboratory of the University of Pennsylvania, kindly placed at their disposal by Prof Marks, one of the committee, and the use of valuable apparatus belonging to other members of the committee, additional apparatus was required, which, if specially designed, must be purchased, or if of existing types, must be borrowed. Then, too, the services of an assistant were required to start and look after the fire for the steam engine, clean out the boiler, run circuits, and do such other work as the committee could not be expected to do.

In order to obtain for these tests currents similar to those used in actual practice, various dynamo electrical machines would necessarily have to be borrowed. In view of these facts, the committee deemed it but fair to request the association to guarantee a sum sufficient to meet actual expenditures, and further to assume responsibilities for apparatus loaned to the committee, feeling sure that the association could hardly expect the committee to assume such expense in carrying out work of the character entrusted to them. This request, the committee were informed by your representatives could not be entertained. The committee are therefore forced to resign.

Desiring, however, to give to the association such incomplete parts of their work as represented the results of their labors up to this time, they beg leave to submit the following incomplete report:

1. On the preliminary code proposed for the tests on insulation of the conductors, etc.

2. On an incomplete draught of a preparatory code of rules and regulations for the installation of an electric plant intended to serve as a basis of experiment by the committee, and to be sent in printed form to the various electric companies and insurance interests for comment and criticism, before finally being submitted to the association.

As regards the preliminary code of tests, however, your committee wish it to be distinctly understood that they recognize the fact that preliminary tests on such code would in all probability show the code to be impracticable in certain portions, or at least to need modifications or additions.

In the preparation of the following preliminary code the committee bore in mind that leads possessing the requisite durability and efficiency for electric work should possess, as far as possible, the following requisites, viz.:

1. High insulation.
2. Impermeability to moisture.
3. Incombustibility.

In this view we submit the following preliminary code for tests, subject to the changes, modifications or extensions already referred to.

PRELIMINARY CODE.

1. *Leakage Tests.*—(Arc wires). A definite length of insulated arc light wire to be immersed all but the ends in water. The water is connected to one pole, and the copper to the other pole of a machine giving 3,000 volts, which is assumed to be the highest electromotive force ever used in practice. The leakage from the copper through the insulation to be continuously measured by a suitable ampere meter, the measurements beginning immediately on the immersion of the wires, and the tests to be stopped when the leakage reaches a certain definite amount. The greater or less rapidity of increase of leakage may then be assumed to indicate the less or greater value of the insulation.

INCANDESCENT WIRES.

Incandescent wires will be subjected to similar tests, differing only in the voltage to which the insulation is to be subjected, which will be in the neighborhood of from 100 to 150 volts, since, as is known, at a voltage of say 60 volts, moisture does not seriously intefere with ordinary underwriters' wire, while a somewhat higher voltage will set fire to wood through underwriter's insulation.

2. *Absorption Tests.*—Coils of wire of definite length are immersed in water and their ability to resist penetration or absorption thereof will be measured by the increase in weight after equal duration of immersion.

3. *Frost Tests.*—The ability of the insulation to resist the disintegrating effects of frost, on the alternate freezing and melting of the absorbed moisture, will be tested by the similar effects produced by the alternate absorption and crystallization of a solution of some chemically inert salt, such as magnesium sulphate. After the wires have been subjected to the frost tests (3), the leakage tests (1), and the absorption tests (2) will be repeated.

4. *Flexibility of Insulation.*—A definite length of wire will be wound around a small cylindrical rod, say one inch in diameter, after which the leakage and absorption tests (1) and (2) will again be reported.

5. *Abrasion Tests.*—A definite length of wire will be bent in the form of an inverted U, having a given radius of curvature, and will be flung over a wheel, such for instance as a gear wheel having polished teeth with rounded edges, and heavy weights will be attached to the two ends of the wire. The wheel will then be turned and the number of turns noted before electrical contact is made between the copper of the wire and the metal wheel.

6. *Adhesion of the Insulation.*—A definite length of wire is bared of its insulation at one extremity, and the bared end passed through a closely fitting hole in a die plate. A measured pull is then exerted on the bare end of the wire until a definite length of the insulation is stripped of the wire.

7. *Refractory qualities of the Insulation.*—The current will be passed through, giving specimens of the wire, and increased in quantity, until the insulation is destroyed, and the nature of the destruction noted, whether in the form of flame, charring, etc., etc.

8. *Ignition Tests.*—The ability of the insulation to resist ignition by some external source of heat, similarly applied to all the wires, and the rapidity with which the flame started at one point travels along the wire, will be carefully noted.

Besides the foregoing tests as to the quality of the insulation, the committee also proposed testing the conductivity and flexibility of the copper, as follows, viz.:

9. *Conductivity Tests.*—The conductivity of the copper will be measured, assuming the wire to have the diameter claimed by the makers.

10. *Flexibility Tests.*—A given piece of wire will be bent repeatedly backwards and forwards, around a templet, curved to a quadrant of, say, one inch radius, the number of bendings required to break it being noted. In order to procure wire of the same quality as that commercially sold in the open market, it was proposed to purchase the specimens tested in the open market, direct from the makers.

The second duty charged on the committee was, as already stated, the preparation of a code of rules, based on actual experience, for the general installation of plants, both so far as concerns the insulation thereof and for the protection of the plant, consumers, attendants and buildings. The importance of a code of rules of this character, relating, as it does, to the better protection of life and property, is generally recognized, both by electric lighting and insurance interests. It is to the true interests of the electric lighting companies to assure the public that, not only can they, through electricity, furnish a steady, reliable and cheap illuminant, but that such illuminant, if intelligently employed under certain well-considered regulations, is as safe, indeed, far safer than any other artificial illuminant. While, therefore, electric lighting companies should not hesi-

(*Continued on page 7.*)

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GEO. WORTHINGTON, - - - Editor.
CHARLES W. PRICE, Associate "
LOREN N. DOWNS, President.
ANDREW J. DAM, - Vice-Pres't and Treas.
C. C. HASKINS, } Consulting Electricians.
GEO. A. HAMILTON, }

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Prof. Reckenzaun is the authority for the statement that experiments have shown that the horse-car rail in use in this country does not necessitate the employment of as much motive power for street cars as the use of the English or narrow-grooved rail. The American type of rail requires about 15 per cent. less power, there being practically no loss from friction in the broad groove.

While conversing with a celebrated English electrician, the question was asked why Englishmen published so much more literature on technical electricity than any other nation? "We are more ready to ventilate our ideas. As soon as we think out a new application of an old principle, discover a new method, or invent a novel device, we straightway publish the results of our work, though it may be very imperfect and undeveloped. Preliminary papers setting forth the course of experimentation an investigator intends to pursue are often read before the various scientific associations. The progress in science achieved by American experimenters in the domain of practical investigation is none the less valuable and important. It is useless to complain that one does not have credit for unpublished inventions and investigations. It is not just that the advantages from mechanical, electrical, or chemical secrets, as well as the credit for their discovery, should be given one person when another gives his works freely to the world."

The "Old Timers" enjoyed a pleasant reunion in Philadelphia this week.

The telephone convention is next on the convention programme, and will be held at Pittsburgh, commencing September 26.

The report of the proceedings of the convention of the National Electric Light Association at Boston, last week, is given a great deal of space in our columns this week, and all our readers will find in the report much that is interesting and instructive.

There are a great many new things appearing daily in electrical circles, but we think Mr. Edison's new heat dynamo, described before the Association for the Advancement of Science, will be received with as much surprise and comment as anything the great inventor has announced in several years.

In all the recent discussions on the application of electricity to street cars as a motive power, it has been assumed that there must be some method to gear down from the armature of the motor to the car-axle, and that the construction of a low speed motor, which could be attached direct to the axle, could not be constructed at a reasonable cost so as to work economically. By the employment of an intense magnetic field a reasonable output per pound of metal can be obtained in dynamos at rates of speed not below 300 revolutions per minute. The limit has undoubtedly been reached as far as regards the strength of field, and no improvement can be looked for in this direction unless the number of pole pieces be largely increased. A well-known English machine gave nearly double the output with four pole pieces that it did with two. The number can be increased to a dozen or more with a large increase in the average strength of the field in which the armature revolves, and a correspondingly less number of revolutions are required to develop the same power as before. The revolutions may also be decreased in proportion as the diameter of the armature is increased. It would seem, therefore, that in view of the need of a slow speed motor for street car use that inventors will not be slow in supplying the demand.

ELECTRIC BANQUET.

Not one of the least delightful things of this last week was the magnificent banquet given by the Thomson-Houston Company, of Lynn, to its friends and the members of the Boston convention, under the auspices of the Boston Electric Club. The noon hour was spent in a delightful trip down the harbor to Deer Island, where the gentlemen, as guests of the city of Boston, were served with a lunch, and were shown over the Reform School and Penitentiary, as some one facetiously remarked, to show them what they would come to if they remained in the electric light business. In the afternoon the immense factory of the Thomson Houston Company in Lynn was visited, the guests being taken into every department, in detachments of about a dozen persons, under the care of some member or employe of that house.

In the evening a banquet was served in the north dining room at the Point of Pines Hotel, the like of which has not been known in the memory of electric men.

About three hundred gentlemen sat round the hospitable board, and the resources of the immense hotel were devoted to providing the sumptuous repast.

At the head of the table Dr. Moses presided as toastmaster, of whom it might well be said, in the words of Sir Philip Sidney, "He cometh unto you with a tale which holdeth children from play, and old men from the chimney corner;" for in the varying moods of the evening he sounded the key-note of the occasion with so true a touch that, to toast after toast, three hundred glasses were raised with spontaneous enthusiasm.

Among the gentlemen who spoke were Mr. Morrison, Mr. Coffin, Mr. Slattery, Mr. Duncan, Mr. Barton, Mr. Kerr and Mr. Reckenzaun.

It was the opinion of several gentlemen who are qualified to express an opinion, that it was the most notable electrical dinner ever given in this country, or in the world.

THE ELECTRIC LIGHT CONVENTION IN BOSTON.

It is oftentimes easier to look into the future and predict the purport of coming events, than it is to look into the immediate past and sum up in appropriate words the things which are so fresh in our minds that we have had no time to arrange them in an orderly manner, or to clothe their memory in a becoming garment of language.

Not only the electric light fraternity, but the community at large has felt the influence of the recent convention held in Boston. The statements made by Mr. Steuart as to the importance and strength of the association were not overdrawn; there is hardly a section of this country that was not represented. Gentlemen from the Golden Gates of San Francisco and the most easterly cities of the country extended the hand of commercial good wishes and prosperity to their fellow co-workers who illuminate the great cities on the Gulf of Mexico and the most northern cities of this Republic.

Nor was the representation of area of country greater than the representation of diversity of trade.

Manufacturers, inventors and construction companies of all sorts have learned that they cannot afford to deprive themselves of the privileges of these conventions. The one which has just been held represented more various trades than perhaps have ever been brought together at any one convention in this country.

All of criticism must of necessity be comparative, and in eulogizing what has just been done, we must compare it with what has been done in the past, and in so doing, we must not be construed as reflecting upon the efforts made in other cities in which the National Electric Light Association has previously held its meetings.

To any one who has attended a number of these conventions, certain changes from year to year may be noticed; perhaps one of the most marked changes is the better feeling and greater confidence which these meetings from year to year have promoted. No one could listen to the addresses and the free and easy discussions which were held on last Tuesday, Wednesday and Thursday in Boston, without feeling that the uppermost thought in the minds of everyone was to impart the most accurate and useful information which he himself possessed, and to gain from others the information which he felt assured that others would willingly give him. This is a condition of things that is rarely attained in trade associations, and we most heartily congratulate the members of the Boston Convention in this respect.

In connection with this we cannot refrain from alluding to the spirit of disinterested frankness which was shown in the matter of officers for the ensuing year The office of president is one fraught not only with many duties and cares, but also with honor and distinction.

The action of Mr. J. Frank Morrison, in tendering his resignation, earned for him the increased respect from every one; and the action of the leading gentlemen in the association, publicly debating in his presence upon the acceptance of his resignation, many of them advancing strong arguments in favor of it, with perfect good feeling all around, and an entire absence of embarrassment lest their motives might be misconstrued, showed an honest freedom of speech and feeling that argues well for the future life and prosperity of the association.

That the convention, after careful consideration of all the arguments, pro and con, decided not to accept Mr. Morrison's resignation, was a wise act no one will doubt; that he will still serve in high place, insures a forcible, loyal administration in the future.

There appears to be a marked improvement in the work of the various committees. The Committee on Patent Legislation is well organized and has laid out a plan of future action which, if carried out, will be a boon to every inventor and manufacturer in the land. The Committee on Wire Gauge has furnished the association with a systematic mathematical report which meets with the approval of thoughtful men.

As was ably said on the floor of the convention, the permanent adoption of their work will be a question of the survival of the fittest. No man can now tell if in a few years the work of this committee will be found only in the text books of electrical science, or in the workshop in daily use. Of one thing we are sure, their work will not pass unnoticed and will receive the commendation and criticism it merits.

The report of Mr. Slattery upon the distribution of alternating currents by the use of the induction coil, and the intelligent and instructive discussion and criticism thereon, will not soon be forgotten by those who were present.

Space prevents our alluding to the many things that deserve courteous mention, but we extend to the association, not only our most hearty good wishes, but the conviction that their sun is not yet in the zenith, and that their next convention is looked forward to with pleasant anticipations.

ADVANCEMENT OF SCIENCE.

Probably the most interesting and instructive meeting of the American Association for the Advancement of Science was the one just closed in this city. There was an attendance of from six to eight hundred, and the papers were particularly able and valuable. We shall publish a number of them in subsequent issues.

Prof. Geo. F. Barker read an intensely interesting paper prepared by Mr. Thomas A. Edison on his new "Pyromagnetic Generator," in which is advanced the novel idea of the conversion of heat into power directly by means of magnetism, and, by the same principle, the conversion of heat into electricity. Of his discovery, Mr. Edison says:

Since whenever a magnetic field varies in strength in the vicinity of a conductor, a current is generated in that conductor, it occurred to me that by placing an iron core in a magnetic circle and varying the magnetizability of that core by varying its temperature, it would be possible to generate a current in a coil of wire surrounding this core.

Acting upon this idea, Mr. Edison placed eight electro-magnets in a circle, all their positive poles in contact with one iron disk, and their negative poles in contact with another. Passing through the disks and joining them, he placed an equal number of rolls of thin corrugated iron, each roll opposite the two poles respectively of the electro-magnets. He wound the eight iron rolls with insulated wire. When this simple apparatus was placed over a furnace so that hot air passed through the rolls, they became straightway non-magnetic. Then he fitted a semi-circular plate below the lower disk to shut off the heat from half the rolls, so that they became magnetic, and half, being hot, were non-magnetic. By revolving this semi-circular plate the rolls were first heated and then cooled, and by this means electricity was generated in the coils of wire surrounding the rolls. Mr. Edison thinks that this device can be so modified as to furnish electric lights for a whole house by means of the heat from an ordinary furnace, and he will pursue his interesting experiments in that direction.

The next meeting of the association will be held at Cleveland on the fourth Wednesday in August, 1888. Major J. W. Powell, United States Geologist at Washington, was named for President, and for General Secretary, Prof. J. C. Arthur, Lafayette, Ind. Vice-Presidents by section: Physics, Prof. A. A. Michelson, of Cleveland, Ohio; Chemistry, Prof. C. E. Monroe, of the United States Navy, Newport, R. I.; Mechanical Science, Prof. C. W. Woodward, of the Washington University, St. Louis.

After much litigation, the electric gas-lighting interests, represented by the Electric Gas-lighting Company, of Boston, and A. L. Bogart, of New York, have perfected a union of interests, and notice is given to the effect that all infringement of the patents owned by these two companies will be proceeded against. A list of the patents is given. This understanding will simplify the electric gas-lighting business of the country, which will now be backed by a strong and undivided combination of the two manufacturers above mentioned.

THE ELECTRIC LIGHT CONVENTION ATTENDANTS.

ALPHABETICAL LIST WITH ADDRESS AND BUSINESS REPRESENTED.

Alleghany County Light Co., Pittsburgh—S. A Duncan, T. Carpenter Smith.
American Electric Manufacturing Co., New York—H. C. Adams, Samuel Elder.
American Electrical Works, Providence—Eugene F. Phillips, W. H. Sawyer, P. C. Ackerman, New York, C. R. Remington, Jr.
Auburn & Lewiston Electric Light Co—N. J. Jordan.
Adams & Co., Thos. B., Boston—Howard Fairbrother.
American Tool & Machine Co., Boston—W. H. Barker, E. E. Chandler, R. H. Stoyle.
American Watch Tool Co., Waltham, Mass.—A. Webster, C. J. Messer.
American Electric Station Indicator, Boston—J. F. Loughlin.
Armington & Sims Engine Co., Providence, R. I.—Gardiner C. Sims.
Boston Electric Light Co., Boston, Mass.—Mayor Hugh O'Brien, F. A. Gilbert, P. Fahey, A. T. C. Daniels, S. S. Sias.
Ball Electric Light Co., of New England, Boston—H. M. French.
Baker & Co., Newark, N. J.—Cyrus O. Baker, Jr.
Bay State Iron Co., Boston—B. C. Vose.
Baxter Electric Manufacturing and Motor Co.—J. F. Morrison, Benson M. Greene, Wm. Baxter, Jr., Pierre Keilholtz, David E. Evans, T. McCoubray.
Bergmann & Co., Boston—W. C. Livermore.
Bernstein Electric Light and Manufacturing Co., Boston—Henry B. Cram, Oscar S. Bussman.
Blodgett Bros & Co., Boston—A. D. Blodgett.
Boston Electric Protective Association—Geo. W. Adams.
Boston Fire Underwriters Union—D. Killicutt.
Boston Rubber Shoe Co., Boston—G. L. Richard.
Bradley Electric Power Co., New York—C. L. Bradley.
Brady Mast Arm, New Britain, Conn.—T. H. Brady.
Bridgeport Brass Co.—Fred A. Mason, H. D. Stanley.
Bridgeport Electric Light Co.—Henry D. Stanley, J. M. Orford.
Brush Electric Light Co, Rochester—G. S. Munford.
Brush Electric Light Co., Detroit, Mich.—W. W. Leggett.
Brush Electric Light Co., Norfolk, Va.—W. W. Chamberlain.
Brush Electric Co., Buffalo—James Adams, W. S. Frear, J. C. Weber.
Brush Electric Co., Cleveland, Ohio—Geo. W. Stockly, W F. Swift.
Brush Electric Light Co., Philadelphia—A. J. DeCamp, M. D. Law.
Brush Electric Light and Power Co., Savannah, Ga.—T. P. Keck.
California Electric Light Co., San Francisco, Cal.—Geo. H Roe.
Callender Insulating and Waterproofing Co., New York—W. M. Callender, A. W. Butterworth.
Campbell Electric Supply Co.—Frank E. Clark.
Charlestown Gas Co., Charlestown, Mass.—Geo. B. Neal.
Chicago Arc Light & Power Co., Chicago—A. H. Brown.
Citizens Electric Illuminating Co., Brooklyn, N. Y.—Chas. Cooper, E. F. Peck.
Cleveland Electric Motor Co., Cleveland, O.—C. L. Wright, F. E. Pettengill, Geo. W. Mansfield, J. J. Miller, Wm. Henderson, E. B. Gethune, Geo. W. Short, C. A. Brayton.
C. & C. Electric Motor Co., New York—S. S. Wheeler, H. L. Lufkin.
Consolidated Companies, Portland, Me.—F. A. Sawyer.
Danbury Electric Light Co., Danbury—E. T. Wightman.
Davidson Steam Pump Co., Boston and New York.—N. E. Park.
Day Kerite Wire & Cables—Clark B. Hotchkiss, Ralph W. Pope.
Derby Gas Co., Birmingham, Conn.—Chas. A. Nettleton.
Eastern Electric Cable Co., Boston—Henry A. Clark, H H. Eustis.
Edgerton Electric Motor Co., Philadelphia—N. H. Edgerton, T. Warren Coulston, W. E. Sharpe, W. B. Buchanan, Harry Hall.
Edson Recording Steam Gauge Co., New York—Jarvis B. Edson.
ELECTRICAL REVIEW, New York—Chas. W. Price, A. V. Garratt, F. M. Gilley.
Electric Gas Lighting Co., Boston—L. W. Burnham, H. M. Cutler.
Elgin Telephone Co., Elgin, Ill.—Wm. Hubbard.
Electrician & Electrical Engineer, New York—Geo. M. Phelps, Jr.
Electrical Accumulator Co., New York—J. N. Keller, Herbert C. Wirt, Z. Latshaw, A. W. Kellogg.
Empire City Electric Co., New York—W. Irwin Wark.
Enos Electric Railway Co., Boston—C. J. Messer, S. P. Messer; D. Gilbert Dexter, Los Angeles, Cal.
E. P. Gleason Manufacturing Co, New York—E. F. Gennert, Wm. F. Cullen, M. W. Gleason.
Faraday Carbon Co., Pittsburgh, Pa.—Geo. F. Porter.
Fiberite Manufacturing Co., Portland, Me.—Charles H. Brown.
Fitchburg Steam Engine Co., Fitchburg, Mass.—Frederick Fosdick.
Fort Wayne Jenney Electric Light Co., Fort Wayne, Ind.—P. A. Randall, Edward Schaefer, J. A. Jenney.
Geneva Non-Magnetic Watch Co., New York—A. C. Smith, Addison Conkling.
Globe Gas Light Co., Boston—D. W. Lee.
Greeley, The E. S. Co., New York—Miles W. Goodyear, F. A. Magee.
Harlem Electric Lighting Co., New York—John H. Hapgood.
Hartford Dynamic Co., Hartford, Conn.—Chas. H. Wead
Holmes Turbine Waterwheel, Gardner, Me.—P. H. Holmes.
Hawkeye Electric Manufacturing Co., New York—Edgerton Bynner.
Ide Engine Co., Springfield, Ill.—A. L. Ide.
Holmes Burglar Alarm Tel. Co.—F M. Moore.
Jamestown Electric Light Co., Jamestown, N. Y.—Thos. H. Smith.
Jarvis Engineering Co., Boston, Mass.—A. F. Upton, Boston; J. N. Pratt, New York; H. A. Glasier Chicago.
John T. Noye Manufacturing Co., Buffalo, N. Y.—A. A. Noye.
Jones & Bros. Electrical Works, Cincinnati, Ohio—F. Amos Kelly.
Julien Electric Co., New York—C. O. Mailloux, J. L. Kimball, G. F. Galcott.
Kansas City Electric Light Co, Kansas City—E R. Weeks.
Leather Link Belting, Boston—Chas. L. Ireson.
Little McDonald Cut Out, Troy, N. Y.—Norman McCarty.
Locke Patent Damper Regulator, Springfield, Mass.—C. C. Webber.
Louisiana Electric Light & Power Co., New Orleans, La.—Samuel J. Hart.
Malden Electric Light Co., Malden, Mass.—A. E. Bliss.
Mather Electric Co., Manchester, Conn.—N. T. Pulsifer; J. H. Reid, Chicago.
Millville Electric Light Co., Millville, N. J.—Stephen Holbrooke.
Modern Light and Heat, Boston—C. M. Ransom, R. F. Ross.
Municipal Electric Light Co., Brooklyn, N. Y.—Charles Cooper.
Munson & Co., Chicago—J. H. Shay, J. H. Thomas.
National Carbon Co., Cleveland, Ohio—W. H. Lawrence, W. C. Hayes, C. D. Smith.
New York Electric Supply Co—F. E. Kinsman.
New Bedford Electric Light Co., New Bedford, Mass.—William Lewis.
New Bedford Gas Light Co., New Bedford, Mass.—Gilbert Allen, Robert B. Taber.
New England Belt Co., Providence—J. S. Blauvelt.
New England Telephone Co., Boston—A. H. Chapman, F. J. Boynton.
New England Wiring Co., Boston—W. J. Paine, H. B. Prindle.
New Haven Electric Light Co.—Jas. English.
Newton Electric Light & Power Co., Newton, Mass—H. G. Pratt, H. H. Cutler.
N. Y. Electrical Construction Co.—F. G. Cartwright.
New York Electric Light Co., New York—J. W. Pendleton.
New York Insulated Wire Co., New York—J. W. Godfrey; W. B. Dowse, Boston.
North Attleboro Steam Electrical Co.—H. M Daggett, Jr., L. W. Dillon.
Okonite Co., New York—Geo. T. Manson, Willard L. Candee.
Pawtucket Electric Lighting Co, Cambridgeport, Mass.—A. P. Kelley.
Parker-Russell Mining and Manufacturing Co., St. Louis—G. W. Parker, D. R. Russell.
Paterson Electric Light Co., Paterson, N. J.—John F. Noonan.
Peabody & Co., Boston—W. B. Peters.
Richmond Carbon Co, North Adams—C. T. Richmond, G. Richmond.
Riverside & Oswego Mills, Providence, R. I.—R. T. Robinson, W. A. Huse.
Rogers Auxiliary Fire Alarm, Boston—Otis N. Howland, S. P. Wardwell, G. W. Daniel.
Russell Engine Co., Massilon, O.—C. A. Gates.
Rhode Island Telephone and Electric Co., Providence—R. H. Whittier.
Royce & Marean, Washington, D. C.—Fred. W. Royce.
Sawyer-Man Electric Co., N. Y.—Henry C. Davis, Gen. C. H. Barney P. H. Alexander, H. S. Thornberry, A. G. McCluer, T. C. Frenyear, E. H. Thompson, F. E. Alexander, E. C. Angell.
Saco & Biddeford E. L. Co., Saco, Me.—C. E. Atwood.
Schuyler Electric M'f'g Co., Hartford, Conn.—M. J. Wightman, J. A. Dalzell.
Scoville M'f'g Co., Waterbury, Conn.—Leonard Waldo.
Scranton Electric Light Co, Scranton—Robert Reaves.
Simplex Electrical Co., Boston, Mass.—A. F. Mason, A. C. Pond, E. H. Batcheler.
Salem Electric Light Co., Salem, Mass.—Chas. H. Price.
Sprague Electric Motor Co., New York—W. H. McL. Harding; A. F. Starkey, Boston.
Sprague Electric Railway & Motor Co.—F. J. Sawyer, Edward Blake, of Boston.
Standard Carbon Co., Cleveland, Ohio—D. A. Dangler, J. B. Crouse, W. H Boulton.
Standard Underground Cable Co., New York—G. L. Wiley.
Solar Carbon Co., Pittsburgh—S. B. Richards.
Somerville Electric Light Co., Somerville, Mass—H. F. Watts.
South Bend Electric Co, South Bend, Ind.—J. Dutham.
Southwark Foundry & Machine Co., Philadelphia—James A. Pentz.
Southwestern Electric Supply Co., Kansas City, Mo.—W. H. Yeaton.
St. Joseph's Electric Light and Power Co., St. Joseph, Mo.—W. C. Stewart.
Sun Electric Co., Woburn, Mass.—Frank Ridlon, M. M. M. Slattery, J. E. Talbot.
Syracuse Electric Light Co., Syracuse, New York—A. P. Seymour.
Telephone Improvement Co., Boston—Horatio N. Holbrook.
The Electric Construction and Supply Co., New York—F. E. Kinsman.
The Electrical World, New York—C. E. Stump, T. C Martin, Joseph Wetzler, W. I. Barker.
Thomson-Houston Electric Co., Boston, Mass.—Elihu Thomson, Chas. A. Coffin, S. A. Barton, W. B. Hosmer, E. W. Rice, H. W. Burgett, H. N. Curtis, G. W. Davenport, A. S. Rohrer, W R. Kimball, W. R. Caulkins, E J. Richards.
Thomson-Houston Electric Co., Chicago—G. W. Atkinson, F. H. Soden.
Thomson-Houston Electric Light Co., Kansas City—Theo. P. Bailey, Chas. S. Rusling.
Thomson-Houston Electric Co., Duluth, Minn.—J. F. Patten.
Thomson-Houston Electric Co, Gloversville, N. Y.—J. A. Miller.
Thomson-Houston Electric Co., Phila.—E. D. Mullen.
Troy Electric Light Co., Troy, N. Y.—J. A. Powers
United Electric Co., Springfield, Mass.—J. W. Hyde.
U. S. Electric Co., Baltimore, Md.—P. O. Keilholtz.
U. S. Illuminating Co., N. Y.—E. T. Lynch, Jr.
Virtrite & Luminoid Co., N. Y.—Romaine Mace.
Waite, Williams & Co. Boston—Geo. W. Waite, E. H. Williams, C. Niles Goward.
Western Electric Co., New York and Chicago—F. W. Harrington.
Western Electrician, Chicago—W. A. Kreidler.
Westinghouse, Church, Kerr & Co. New York—W. C. Kerr, Isaac H. Davis.
Westinghouse Electric Co.—Walter C. Kerr, W. Stanley, Jr., Alex. P. Wright.
Whittier, R. H., Providence, R. I.
Worcester Electric Light Co, Worcester, Mass.—H. H. Fairbanks.
Washburn & Moen, Worcester—Henry M. Smith.
Waltham Electric Light Co., Waltham, Mass.—F. G. G. Hill.

ALPHABETICAL LIST OF ATTENDANTS NOT RECORDED AS CONNECTED WITH COMPANIES.

Andrews, Chas. H., Boston.
Bibber, Chas. E., Boston.
Blake, W. H., Sawyer, Mass.
Brigham, W. V., Newton.
Brown, F. N., Newton.
Brophy, W., Boston.
Bolton, J. B., New York.
Barnard, G. W., Boston.
Barton, S. E., Boston.
Churchill, J. H., Boston.
Collins, W. H., Boston.
Cutter, H. W., Boston.
Candee, John N., Poughkeepsie, N. Y.
Carhart, E. M, Providence, R. I.
Chandler, E. E, Boston.
Clark, W. G., Chelsea.
Clarke, Thos. W., Boston.
Cabot, F. E., Boston.
Davidson, W. F., Port Huron.
Dodge, James Hale, Boston.
Dowd, P. A., New York.
Dowd, F. C., New York.
Daniels, A. L. C., Boston.
Darley, J. W., Baltimore, Md.
Darling, L. N., Pawtucket, R. I.
Edgar, C. L., New York.
Edson, J. B., New York City.
Edwards, John R., Washington, D. C.
Fuller, Frank, Boston.
Frenyear, T. C., Boston.
Finley, N. D., Boston.
Fisher, Frank A., Boston.
Fitch, Robt. J., Boston.
French, F. E. Boston.
French, Z. F., Boston
Flanders, B. S., Boston.
Fleming, W. H, Liverpool, England.
Flint, John, Brooklyn, N. Y.
Gallagher, F. E, Boston.
Gilman, Col. E. R., U. S. A.
Groot, W. L., Orange.
Hill, F. M., New York.
Hill, W. S., Boston.
Hunt, Thomas, Brighton
Hillman, S. B., Philadelphia, Pa.
Howland, T. O., Boston.
Hutchins, W. F., Boston.
Hutchings, A. W., Boston.
Huse, W. A., Providence.
Hartwell, Geo. H., Boston.
Hatch, Jr., J. B., Boston.
Hall, W. A., Boston.
Haynes, Jas. G., Boston.
Hamblin, H. W., Pawtucket.
Harding, W. H., Baltimore, Md.
Hendire, J. A., Boston.
Kellogg, B. W., Boston.
Kitfield E. H., Boston.
Joyce, Martin, Medford, Mass.
Learing, Lewis, New York.
Leavitt, Thos., Boston.
Lockwood, Thos D., Boston.
Lytle, H B., Providence, R I.
Lowell, Frank F., Boston.
Meredith, Irving S., Boston.
Mitchell, D. L. Taunton, Mass.
Monfort, J, Bridgeport, Conn.
Moses, Dr. Otto A., New York.
Mendell, W. H., Boston.
Martin, John B., Boston.
Meyer, W. C., Boston.
McCallum, A., Northampton, Mass.
Meigs, Jos. V., Boston.
Mendell, W. H., Boston.
Noble, Edmund, Boston.
Packard M. M., Baltimore, Md.
Peirce, C. H., Northampton, Mass.
Powers, G. C., Panama R. R.
Powers, C. W., Boston.
Prentiss, R. W., Columbian University.
Priest, B. E., Boston.
Rand, C. W., Boston.
Rand, W. M., Lynn, Mass.
Razee, R. E., Mansfield.
Richardson, G., Boston.
Reckenzaun, A., London, England.
Ross, G. S., Boston.
Ryan, R. W., New York.
Russell, A. L., Boston.
Sautey, J. P., Boston.
Sims, Thomas C., Boston.
Sparrow, E. P., Boston.
Silsby, W. H., Newbury, Vt.
Spaulding, E. S.
Stockbridge, G. H., New York.
Smith, Jesse W., Detroit.
Savage, W. B., Boston.
Steuart, Arthur, Baltimore, Md.
Smith, H. H., Syracuse, N. Y.
Toland, Hugh J., Supt. of Lamps, Boston.
Wright, L B., Boston.
Wightman, E. T, Danbury.
Wightman, M. J., Hartford.
Williamson, John J., Boston, Mass.
Willington, W., New York.
Wist, Herbert C., Boston.
Woodbury, C. J H., Boston.
Wyman, Dr. H. B., Boston.
Walls, H. F., Somerville, Mass.

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Vice-Presidents.—E. R. Weeks, Kansas City, Mo.; A. J. DeCamp, Philadelphia, Pa.
Secretary and Treasurer.—W. H. Harding, Baltimore, Md.
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The Boston Electric Club.

The first reception of the Boston Electric Club was held August 8, at the club rooms, 66 Boylston Street. The workmen had only that morning put the finishing touches on the lower room, in which the meeting was held. At 9 o'clock P. M. President Ridlon called the meeting to order. He said that the object of the club was to promote the social intercourse of different persons interested in the various branches of the electric business. Papers of scientific and educational interest would from time to time be read before the club and discussed.

Secretary Garratt apologized for any shortcomings they might find in the furnishings of rooms; that not a single thing was in the rooms on Saturday (here the arc light winked), and the entire work was completed between that time and Monday night. Colonel Ransom predicted a brilliant future for the club. Superintendent Chapman, of the New England Telegraph and Telephone Co., spoke in a happy vein of the success of the club. Mr. Slattery, in one of his most felicitous moods, predicted diagrammatically and algebraically the work that the club would do for electricity.

Telephonic News

*** The Western Electric Company have secured contract for lighting Chicago river. Russell & Co's automatic engines will be used.

*** Electricity is now utilized by the submarine diver in the form of a 50-candle incandescent light fixed to the top of the helmet with a powerful reflector, and in a telephone fixed inside the helmet by which the diver can converse with his assistants above water.

*** The induction system of train telegraphing on the Lehigh Valley Railroad is working extremely well and is quite largely patronized by passengers, who pay an extra 10 cents for sending messages over the Western Union rates. The "telegraph office" is in the drawing-room car.

*** Copenhagen has a telephone cable-system 16 miles in aggregate length, underground, aerial and submarine. The underground system has wires 0.31 in. diameter for short distances, and 0.039 in. for long distances. Each underground cable contains 27 insulated conductors, with 3 copper wires to serve as earth, and the whole enclosed in a double lead sheathing covered with asphalted tape over all. The aerial cable has 26 conductors of the smaller diameter, with less insulation, and laid up in a strand with 19 steel wires to serve as a carrying rope. The whole is covered with fire-proof tape and painted white. The submarine cable contains 30 gutta-percha covered wires protected by a heavy armoring of iron wires.

*** In speaking of the alleged concessions to Wharton Barker and other Americans by the Chinese authorities, John Russell Young, ex-minister to China, said recently: "The special telephone concession may have been granted, but it would be interesting to know the conditions. There were telephones in China long before I left there; an admirable system in all respects, and any concession would be for an opposition line. China has no patent laws, and in lieu of patents concessions are necessary. They are not given in a hurry or without adequate reason. A concession for a rival telephone line to compete with the China and Japan company now in existence would have about the same value as a concession to the Baltimore and Ohio to run their telegraph lines in Philadelphia against the Western Union. There are also thousand of miles of telegraph wire. I have telegraphed from Pekin to Washington and had a reply the next day. The telegraph is under the control of the government. There can be no doubt that no country in the world offers better facilities for development than China, but all such advance must be governed by the laws wich govern process elsewhere. The Chinese are shrewd, able people; there are no better business men. They are conservative because the conditions of life in a dense population especially make them so. It is one thing to develop 100,000 square miles inhabited by a few bands of roving Indians, as you will find the Rocky Mountain regions, and another to develop a province of 50,000 square miles with a population of 30,000,000 to 50,000,000. In all matters of development there will be an intense rivalry among the foreigners. All the money-making world seems anxious to lend money to China. If Mr. Barker and his friends have a concession, and I should be glad to know they have a good one, it was a mistake to allow it to go into the newspapers in this form. It has already attracted the attention of the house of lords, and will sharpen competition among other powers and alarm the Chinese, who will at once be put under pressure. In nothing is reserve of more importance than transactions of this nature with China."

Mr. Preece on the Progress of Telegraphy.

Mr. Preece's paper on "Fifty Years' Progress in Telegraphy," read before the Society of Arts at their twenty-first ordinary meeting, was a fit subject for this the jubilee year of the electric telegraph. Mr. Preece traveled over the ground in his well-known popular style, and the reliable data he was able to bring forward greatly interested his audience. Referring to the business done at the Central Telegraph Office, Mr. Preece said: "The development of telegraphy is better shown in our great central station than anywhere else." The following table is interesting:

Date.	One day's Messages.	Instruments.	Staff.		
			Male.	Female	Total
Before the transfer..	8,500	....	....	....	....
1870..... ..	12,000	350	280	485	765
1880.....	43,000	486	826	598	1,424
1886..	98,570	945	1,490	802	2,292

The number of messages dealt with each day ranges from 70,000 to 100,000, nearly half of which are transmitted messages which have to be both received and forwarded, and therefore become practically two messages although they count as only one in the total. The local traffic in London —that is, messages emanating from one part of London for delivery in some other part and passing through the central station—is very large. It ranges from 12,000 to 18,000 messages per day. In 1868 there were sixty offices open in the metropolis dealing with 300 messages per day. There are now 480 offices dealing with an average of 15,000 messages a day. The total number of local metropolitan messages for four weeks was: February, 1870, 138,534; January, 1870, 726,199; January, 1887, 1,277,838—a tenfold growth nearly.

APPARATUS.

It is, perhaps, in the character and form of the apparatus used to transmit messages that the greatest progress has been made. It is difficult to say whether increased business has led to better apparatus or whether improved apparatus has led to large business.

One thing is certain, that the better the work is done, the more is business encouraged, and work cannot possibly be well done if the apparatus used for discharging that business is inefficient or backward. When the Post Office assumed the control of the telegraphs, it amalgamated into one department an incongruous combination of various systems, worked by differently trained staffs, due to various companies having been formed at different periods to work different patents. The Electric Telegraph Company established the needle system of Cooke and Wheatstone, the printing system of Bain, which merged into that of Morse, and the various improvements patented by Varley; the Magnetic Company fathered the magnetic system of Henley and the Bell system of Bright; the British Company introduced the system of Heighton; the United Kingdom Company promoted the beautiful type-writer of Professor Hughes; and the Universal Private Company was established to introduce the simple A B C system of Wheatstone. We had telegraphs that appealed to the eye, like the needle; those that appealed to the ear, like the bell; some recorded signals in ink, like the Morse; others printed their characters in bold type, like the Hughes. Some were slow, but simple, like the A B C; others were fast, but complicated, like the automatic. Time and patience were needed to consolidate into homogeneity this heterogeneous collection of telegraphs and telegraphists. Some years elapsed before the doctrine of the survival of the fittest was established. Now, in 1887, the predominant telegraph instruments are the simple sounder and the fast-speed automatic recorder.

Reading by sound is confined almost exclusively to the United Kingdom and to the United States. In Europe there is scarcely a sounder outside our islands. This is very remarkable, for the sounder is simpler, more expeditious, and more accurate than any other key system. Those who have been educated to regard a record as an element of accuracy can only be convinced by actual experience that it is an element of error, and this experience they will not seek. The argument they use against the adoption of the sounder, viz., its liability to error, is devoid of any foundation in fact. During the past ten years, a complete revolution has been effected in the quality and manufacture of our instruments. Exact measurements and scientific principles have supplanted rough and ready methods. Complete specification and rigid inspection have replaced cheap and nasty competition. The workmanship of a good telegraph instrument is to be rivaled only by that of a chronometer. Technical training has converted the workship into a scientific laboratory.

The rapid increase of business that resulted from the uniform shilling tariff soon led to the erection of more wires, and the multiplication of wires soon attracted attention to methods of duplexing and quadruplexing the circuits. The duplex system means a mode of sending two messages in opposite directions at the same time. This was shown to be possible by Gintl, in Vienna, in 1853, but the necessity for such a system did not arise until 1872, and as at the moment a want is felt, something is sure to turn up to supply this want, so when duplexing was needed, Mr. Stearns arrived from America with a well-worked-out practical system, that was at once adopted, improved, and perfected. Still further congestion arising, quadruplex working, or the art of sending four messages on one wire at the same time, became desirable, and a practical quadruplex system, due to Mr. Edison, was imported in 1877 from the same inventive and practical region, the United States.

The work of the Austrian, Meyer, ought also to be referred to. Later on, in 1885, a still further development was matured in America, viz., the multiplex system of Delany, by which six messages can be simultaneously sent on the same wire, which we have adopted, and the main features of which I now show you in action. The chief reason why these systems have been matured in America is that the want has been experienced there before it was felt here. Neither system was invented in America; each was invented in Europe. There are other wants that have been experienced here first, and those who have visited the States have found that English inventions are equally appreciated and adopted there. It is in automatic telegraphy that we have made the greatest advances. The following table illustrates the progress made:

	Words per minute.	Speed to Ireland.
1870.....	80	50 3
1875.....	100.....	70
1880.....	200...	150
1880.....	350.....	250
1887.....	450....	450

This increase has been due not only to improvement in the design of the apparatus, but to the steady examination of every defect and its removal, in the instrument and on the line. It would require a paper of itself to narrate the ten years' conflict with electro-magnetic inertia, static induction, climatic influences, and battery defects. The table tells the result of this conflict, and the battle is not yet over. There still exists in our system a potentiality of expansion. We are now attacking the wires. Copper is replacing iron on our poles with very advantageous results. Its better conductivity, and its entire freedom from electro-magnetic inertia, give it an immense superiority over iron. Its greater price per ton is compensated by its lesser weight per unit resistance.

We are also examining and testing various modes of laying wires underground, with a view to attaining greater speed of working hitherto the great difficulty which has checked the establishment of underground work. One consequence of the introduction of these advanced systems of working has been the neeessity of educating the operating staff in the scientific and technical details of the business. The absence of technical knowledge in all branches has hitherto been a great difficulty to surmount.

The technological examination inaugurated by this society and continued by the City and Guilds Institute have been most beneficial, but the most successful incentive has been the selection and promotion of those who have given their attention to their own scientific education.

This evident necessity for technical knowledge is reacting on the higher post-office officials, and one finds all over the country a healthful spirit of inquiry arising—a striving after something better than the mere perfunctory discharge of official duties. There is something so capitivating in the development of the practical applications of electricity that those who make a study of it, especially experimentally, find in it more real enjoyment than any puzzling over the vagaries of the modern poet or poring over the meaning of ancient cynics can afford. A successful experiment is a distinct revelation—an admission into courts where, according to Bacon, are found "secrets not dangerous to know, sides and parties not factious to hold, precepts not penal to disobey."—*The Telegraphist.*

Turbine Wheel and Dynamo Coupled Direct.

The illustration on page 11 represents a Girard turbine constructed with a horizontal shaft. In order to obtain moderate speed under a high head, the wheel is made very large in diameter, and the water is admitted to a small portion only of the internal circumference of the wheel by means of five guide ports. A slide worked by hand through a worm with wheel and pinion closes the guide ports in succession, and also serves as a stop valve. The wheel is 42 inches internal diameter, and the vanes or buckets are formed of steel. A wrought-iron cover, not shown in our illustration, is placed over the wheel, to prevent the water splashing into the turbine house. The turbine is enclosed in a strong cast-iron case. The regulation is effected by a single guide port furnished with a gun metal slide. By means of a hand wheel and worm, gearing into a wheel connected to a screw, this slide may be moved up or down so as to increase or decrease the discharge area of the port.

The Chicago Electrical Development Company.

The Chicago Electrical Development Company, with its present office at 171 Randolph street, Chicago, has been formed for the purpose of placing inventions of merit on the market. The company has advantages which will enable them to accomplish this result speedily and with good assurance of success. Patents and inventions will be bought outright for articles manufactured and sold on royalty

.... Mr. J. Pender, speaking at a dinner in London last month in celebration of the jubilee of the electric telegraph, on behalf of "The Present," said he would tell them what submarine telegraphy had done. Twenty years ago there was only about 3,000 miles of submarine cable. There were now 115,000 miles which had cost something like £38,000,000 or £39,000,000. A prophecy was made long ago that the earth was to be girdled in forty minutes. We have got as much submarine cable as would go round the earth five times. A message could be sent round the world in twenty minutes at the present moment. They might ask him where did all this submarine telegraph extend to. In reply he would use those beautiful lines:

> "Far as the breeze can bear the billows' foam,
> Survey our Empire and behold our home."

Wherever the British ship penetrated and the British flag waved the submarine telegraph was to be found. When the history of those past fifty years was written it would be shown that telegraphy, and more especially submarine telegraphy, had done much to confederate the great colonies and the mother country, to spread civilization throughout the world, and to have made as near as possible this great world of ours one common country.

ELECTRIC LIGHT AND POWER.

(*Continued from page* 3.)

tate at the adoption of the most stringent regulations that experience has found necessary for the protection of either life or property, it is, of course, advisable that all arbitrary and meaningless regulations should be carefully considered before their adoption by the National Electric Light Association. It has therefore been the aim of your committee to obtain a code acceptable alike to electric lighting and insurance interests.

As preparatory to the framing of such a code of rules, the committee planned the following work, viz.:

1. The preparation of a compilation of existing rules.

2. Obtaining the opinions of the principal electric light and insurance companies, as to the practicability of existing rules, and requesting suggestions of such changes or additions, if any, their experience might suggest.

2. Conducting a series of experiments so as to determine, as far as practicable, reliable data on which a code could be deduced affording the widest latitude to electric light and power companies consistent with absolute safety to life and property.

4. From the above to deduce a code to be regarded as a preliminary code.

5. To have printed copies of such preliminary code sent to all electric light and insurance companies for comment and criticism.

To prepare finally a code to be submitted to the National Electric Light Association of America.

In carrying out this branch of its work, the committee has addressed letters to electric lighting and insurance interests, asking for copies of existing rules, etc. To a certain extent these letters have been answered and copies of existing rules and regulations (though by no means complete) have been received, and the committee had commenced a compilation of the same. In the desire of aiding the association they hereby respectfully submit such incomplete collection and compilation.

Being forced to abandon their work by reason of the failure of the association to make the appropriation necessary to carry out the same, the committee hereby submit the above incomplete report, and respectfully offer their resignations as members of the committee, and request that they be relieved from any further work in the matter.

Respectfully submitted,

EDWIN J. HOUSTON,
Chairman.
WM. D. MARKS,
CARL HERING,
M. M. GARVER.

MR. KINSMAN: Is there any item there in regard to the time test—that is, the cracking of the wire?

THE PRESIDENT: No, sir.

MR. KINSMAN: I move that that be introduced. I have some experience on wires that tested well before we put them in, but did not stand the pressure of time.

THE PRESIDENT: There were no exhaustive tests made by this committee at all. They had completed their work to a point where they required financial aid to carry it on. They applied to the association for that aid. The association was unable to give it, and the committee present this report and resign. It is put in plain and unmistakable language, so that you may know if you want any further work done you will have to pay for it. The paper is open for discussion or for whatever disposition you choose to make of it.

MR. EUSTIS: We have had some little experience in wire. A good many years ago, when I was with the Bell Telephone Company, I decided to test a wire there, and made out a report of the wire. It tested splendidly after soaking for about two weeks. I made out my report, but, fortunately, it was not handed in. I put the wire upon the shelf, and glancing at it I saw that the insulation was cracked from one end to the other, showing that while the wire might test perfectly well while still wet, after it had dried out a trifle it was absolutely no good. For practical working, that, of course, is a strong point, that a wire should last and not become oxydized and cracked. There is also the other question which, I think, should be brought up here, and that is the question of mechanical injury to the covering—abrasion. We all know wires are strung where they are liable to swing—against awnings, the fronts of houses, trees, etc. That, I think, is also a question which should be brought up here.

MR. MASON: I suppose we must decide this question now, whether money shall be appropriated for such an object. I do not suppose, Mr. President, that another committee could be found who would undertake the work which this committee has declined to pursue and undertake it at their own expense. I wish I could hope that I was wrong on that point; but I do not believe that any committee will undertake an expense of a thousand or two thousand dollars and pay it out of their own pockets. At any rate, although I am very anxious indeed, from my own point of view, that the work which was given to this committee shall be done, I do not feel like asking any committee to bear that expense. It seems to me as if the necessary expense of making tests, the results of which would be so valuable to the members of this association—it seems to me that we ought not to shrink from incurring that expense. I want to test this thing, and so, to bring it before you, I move that the resignations of this committee be accepted, and that their partial report be also accepted, proposing to move the appointment of a committee, and the appropriation of a suitable amount of money to enable them to carry out such plans as they shall deem wise for the determination of the end sought by the committee whose resignations are now offered. I move the acceptance of the partial report, and of the resignation of the members of the committee whose names are thereto appended.

The motion was seconded.

MR. DECAMP: I understood from that report as well as from Professor Houston personally that that is not made in the nature of a report—that they could not report, for lack of funds to carry out their investigations. What they have said there is in the nature of suggestion.

MR. MASON: They use the term partial report, do they not, Mr. President?

THE PRESIDENT: Yes.

MR. DECAMP: I do not think that the committee want to be responsible for that report. The question arose in my mind what disposition we ought to make of it.

MR. LEGGETT: It suggests itself to me the same as to Mr. DeCamp, that inasmuch as the committee admits this to be far short of a report, that it would be better to accept their resignation in view of the circumstances which they have set forth and to lay this report upon the table.

The motion was seconded.

THE PRESIDENT: Do you offer that as a substitute for Mr. Mason's motion?

MR. LEGGETT: Yes, sir.

MR. MASON: I understood you to say, Mr. President, that I am right in my memory—that the gentlemen who sent us this communication style it a partial report. I therefore made my motion that their partial report be accepted.

THE PRESIDENT: They style it here: "Report of the Committee of the National Electric Light Association on the Proper Insulation of Wires and the Proper Installation of plant," and they say "The committee appointed by your honorable body respectfully submit the following report."

MR. MASON: And afterwards they speak of it as a partial report. If not, I should wish to modify my motion.

THE PRESIDENT: You better modify your motion; this is a report.

MR. MASON: It would not be in order for me to make that amendment in view of the one before you. I will withdraw the word "partial" with the consent of the body.

MR. LEGGETT: Then I renew the motion that this report, which is admittedly incomplete, and for which the committee would not probably want to make themselves responsible, or the convention desire to accept as an expression of its will, be laid on the table.

This motion was put and carried.

THE PRESIDENT: The Boston Electric Club have extended an invitation to the members of this association to attend a banquet to be given on Wednesday night at the Point of Pines, and they request that the members of the association call at room No. 14 and give a written acceptance of this invitation.

THE PRESIDENT: I hope the members will all be in their seats at half-past two. You have only a short time to consider a great many very important subjects. The first paper will be the report of the Committee on Electrical Distribution by Means of Alternating Currents, by Mr. Slattery. That will be the first paper after the dinner hour. At half-past two o'clock we will begin the business sharp. This paper is a very important one, as it deals with a new branch of the electric business which has been developing quite rapidly of late.

The convention then adjourned until 2.30 P. M.

TUESDAY AFTERNOON SESSION.

The convention was called to order by the president at 2.30 P. M.

THE PRESIDENT: The first business of the afternoon session is the report of the Committee on Electrical Distribution by Means of the Alternating Currents.

MR. SLATTERY: I regret to have to announce the absence of our very able chairman, who had to report upon this important subject, secondary generators. In his absence, that duty devolves upon me, and I feel the onus of the obligation involved of doing justice to a subject which is fraught with a great many perplexities.

REPORT OF COMMITTEE ON ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS.

BY M. M. M. SLATTERY, OF BOSTON.

One short year ago the commercial success of the branch of electric lighting in which induction coils are used was by some of our best authorities considered very problematical, but practical use of the induction system has not only succeeded in commercially converting high tension electricity to low tension for electric lighting purposes, but also high tension theoretical opponents by practical demonstration of facts.

Upon the occasion of the last convention, the extensive use of the induction system received its first authoritative endorsement by our esteemed friend, Dr. Otto Moses, and although he was by some considered overenthusiastic in his statements, time has served to prove the correctness of his views and the realization of many of his anticipations.

We will go back six months, and mentally what do we see in this business, from here a few, experimental plants, scattered about in various parts of the country struggling for public recognition and with the innumerable detail difficulties which dog the footsteps of every new departure, difficulties the magnitude of which are usually in proportion to our ignorance of their nature, and therefore more frequently than not unduly magnified.

Now what have those difficulties been, and has the past six months' experience enabled the manufacturing companies engaged in this branch of business to eliminate them?

We find there were three factors in the induction system that required all the ability of the electrical engineer to work out and place upon a proper footing, namely, the dynamo machine, the induction coil, and the disposition of the external circuit to take the best advantage of the use of the induction coil.

Of course, there were alternating dynamos in existence, as were also induction coils, before this lighting branch of business had acquired any prominence, but they were not such as would meet the new requirements.

We will first take the dynamo. It will be familiar to all of you, that no matter how intimately acquainted you may be with the construction of dynamo machines, when you start in to build a new type, your previous experience, however valuable it may be, does not enable you to foresee innumerable detail difficulties which will assuredly develop with practical use, and which take time to ascertain and remedy.

Well, so far as we have been able to learn, the weaknesses which developed in this apparatus were first, the liability of the current to jump across the coils in the event of the field being excited with the armature circuit open. This open circuit sometimes happened by a dead cross occurring some place in the mains, blowing the fuse at the dynamo. thus opening the circuit, and then the field being fully excited the armature would generate an exceedingly high electromotive force for an instant; the current under the circumstances would be very liable to jump across the coils of the armature and other hurtful effects to the machine would ensue; the remedy for that was inserting at every branch in the external circuit a junction fuse, and at various points along the mains and sub-mains section fuses to such an extent as to make an open main a remote contingency. It was also found that the armatures heated excessively, owing to the presence of the plaguey Foucault currents; it was found that this evil could be almost wholly suppressed by building the armature without iron and avoiding as much as possible the use of masses of metal in proximity with the armature coils. In this connection Siemens' early type of alternating dynamo slightly modified to meet the new requirements might read us a lesson.

It was a bold step when the alternating dynamos were constructed with iron cores, and those who make this class of machine for this high tension incandescent business might give us some interesting information. To my mind this iron core construction speaks of disagreeably high temperature. I do not say that they will not be able to present a rational theory why this evil may not be, or has been, greatly modified, but the fact existed in the past, and, as far as we have been able to ascertain, stands unrefuted at present. One thing, however, is pretty evident, that just now this type of machine appears to be finding a rather extensive use, evidencing that it must be doing good work. So much for the alternating current dynamo, a machine destined to play a most important part in the future electric lighting business, and in the light of the past experience no doubt should exist in the minds of anyone here that these dynamos in practical use are now almost, if not quite, as reliable as any other dynamo; while coupled with this is the important factor of a pretty close self-regulating property attainable in this system, without the necessity for any particular method of winding that property, following chiefly as the result of the use of the induction coils. It is satisfactory to know that during the probation of this system every accident of any importance which has occurred to the dynamos has been of a purely mechanical nature, and our mechanics have reduced them to a minimum.

No doubt the induction coils have been a source of considerable anxiety, not because there was any obstacle in the way of obtaining high electrical efficiency—this latter appears not to have been by any means a difficult problem to solve; the source of greatest trouble has been, as far as I can learn, that of insulation; in what form will the weakness appear has been a question often asked himself by a timid electrician, and as usual the most unlooked for troubles developed. At one time an unaccountable defect in the insulation of the secondary coil would occur, cutting out a number of convolutions, thereby causing annoyance by reducing the incandescence of the lamps in its circuit; the remedy was simple—increase the insulation of the wire and exercise still greater care. The same accident would still more frequently happen to the primary coil—the same remedy applied overcame it; sometimes a number of the layers of the primary coil would thus be suddenly cut out, resulting in

the passage of a much heavier current than he fuse in the coil box had carrying capacity for; the fuse would then melt and possibly draw an arc that you had a great deal rather do without if you could; the remedy for that was, keep on insulating the primary coil layers from each other until the trouble ceased, and increase the distance between the ends of the primary fuse to such an extent that when the latter melted, an arc, no matter how great its volume, would not be able to bridge over the distance, which, after all, was calculable, because the electromotive force was constant. Then again metallic contact would take place between the induction coil and the iron box in which it was mounted, and if that box happened to be placed anywhere near a ground, possibly unpleasant electrical experiences might be related in wet weather. It was again only a question of looking out for the insulation to reduce such defects to a minimum; well—the insulation appears to have been looked out for as the smooth and safe working of that branch of the business would now seem to testify, and to-day that part of the system can be made as reliable, simple, and as easily disposed of as any other part of an incandescent system.

Thus the two new and troublesome factors have gradually and surely been strengthened for their future work.

The next in the system, viz., that method of distribution which would enable you to utilize the induction coil to the best advantage, although apparently presenting the simplest problems at the outset, has required a great deal more thought than was anticipated. It was found that no particular rule, as in the case of low tension distribution, could be carried out, the methods of distribution varying with the condition of the district in which you had to distribute.

In some cases the wires were run out from the central station through the center of distribution, and tapped at any point along the route where lights were required. This was the earliest and simplest form of distribution, and answers perfectly well for comparatively small installations, it being desirable to keep the loss in the mains down to about two per cent., and, perhaps, about two to three per cent. in the induction coils, so that the incandescence of the lamps should not vary appreciably throughout the system. This arrangement of the circuit may be carried out in small and very scattered towns, where it has been found to answer admirably. In other cases, where the district is more densely populated, and a large installation is required, the inductoriums are placed in the centers of distribution, and used like so many stationary dynamos, the light-tension primary current, with comparatively small conductors, feeding each of these centers, the secondary or distributing circuit being taken where lights are required. Still other methods of distribution are carried out. But what has been stated in this connection will serve to show that again the past year's familiarity with the business has given an opportunity to perceive and profit by many advantages the system offers.

One of the last, but by no means the least point that I shall touch upon in this interesting subject is the question of comparative cost of the main conductors required in installation of an induction and low-tension incandescent plant. Not at all unfrequently we shall find ourselves called upon to figure upon a plant like this.

From the source of generation to the point of distribution is one mile and a half, making a three-mile circuit. At the point of distribution you are required to distribute some 400 16-candle lamps at, say, five per cent. fall of potential, which appears to be about the limit allowed the induction system. The necessary conductors for this purpose in the induction systems now in use would be No. 2 Brown & Sharp, which will cost about $230. In the case of the low-tension installations upon the low-tension system, you would require a conductor costing about $1,050.

Should you be required to distribute throughout the whole of the length of the circuit, the wire such as is used for ordinary arc lighting purposes would be amply sufficient for the induction, and of course a proportional reduction may be made in the low tension.

Now, a great many exaggerated statements are made with regard to the dangerous shocks to be expected from this alternating current, and while I am not prepared to say that the physiological experience of a shock from a thousand volt dynamo is the most agreeable thing in the world, I am prepared to say that the shock is by no means as severe as that received from a continuous current dynamo of the same voltage. A few weeks ago a man showed me his hands, which were horribly burned; he had received a shock from an eleven hundred volt dynamo, and he said, with a visible tremor in his arms, as if the recollection of that shock was still vividly impressed upon his mind, that he experienced the effect of that shock for more than a week afterwards. A friend of mine was testing a 400 light 1,050 volt alternating dynamo fully loaded only a few days ago, and going towards the machine his foot slipped and he fell quite close to it; in his confusion he quickly reached out his hands and unfortunately placed them directly upon the poles of the dynamo. He said from where he fell to the wall behind him was about fifteen feet, and it seemed to him as if that dynamo was suddenly converted into an electrical gun, and he got shot across the room, until the velocity of his movement was interfered with by the wall. There was scarcely the appearance of a burn on his hands, merely a pin's head matter, while the effect of the shock was felt by him only a few hours. It might be said that the difference of the effect of the shock was owing to the difference in the temperament of the two men; that may be so, but I have received three pretty severe shocks from a 1,000 volt alternating machine, and however much I may have felt inclined to dispense with the shaking up it gave me, the experience had been of value to me—one cannot have everything.

One word more in conclusion. The induction system has evidently come to stay, not because enthusiastic advocates think or say so, but because the expert public, the central station public have practically endorsed it, because it more nearly than anything else meets their immediate and anticipates many of their future requirements. More especially is its advent doubly welcomed just now with this misconducted overhead conductor warfare pressing on every side, and which is every day acquiring seriousness in proportion to the increase of copper wire in the air, and I think that this system, with its comparatively small mass of conductors, will postpone for a considerable time the necessity of going underground with the electric light wires when more extended experiments shall have given us the confidence in underground systems that experience in the past has materially shaken.

THE PRESIDENT: Gentlemen, Mr. Slattery's paper is now before you for discussion.

MR. SLATTERY: If I might make a suggestion, sir, we have our old friend, Mr. Duncan, present, who is fully charged with alternating effects this afternoon, and we shall be very pleased to receive a shock from him.

MR. DUNCAN: I am not very well charged to-day. It has been a very fatiguing day for me. The atmosphere of this room is not such as was represented by the Mayor of Boston. In regard to the alternating current system, I have simply to say that there is no question about the practical and efficient working of that system. There have been some things which required a practical demonstration to bring them out, and there are some things about the system yet which are not fully solved, but which are being rapidly evolved. There is no question about the covering of a given space and the distribution of a large number of lights much more economical than there is in a direct system. Now, as to the question that comes up in regard to the difficulties suggested by Mr. Slattery, those are questions which are gradually working themselves out, as he stated in his excellent paper. One of the difficulties which was first experienced, as he says, was the induction box itself; but practical experience of four months in the use of that box has been such as to show that in every respect it is entirely efficient and satisfactory, and that it can be determined and relied upon to be placed in any position to do its work effectually and efficiently.

In regard to the dynamo, he has gone through that part of it. There is some heat naturally generated from any dynamo. I do not know that I can say that we get any more heat from the alternating current dynamo than we do from the regular arc light dynamo; I do not think we get much less; I know we do not get a great deal more. In the heating of the parts in the original machines that were made there was considerable difficulty. Insulation has been provided from time to time, and at the present time I know of machines which have run successfully for three months, to which nothing has ever been done. Some of these machines will average in a week's run 24 hours per day, except Sunday, and they will be shut down on Sunday for about 2 hours. In regard to the efficiency of the system, I am satisfied myself from my own knowledge and from the experience we have had with it, that for long distance lighting, for doing city lighting, for covering a straggling community where the lights will be necessarily very much scattered and where it is not a compact part of the city like most centers, that you can do it more efficiently and more economically with that system than you can with the direct.

I don't know of anything else I could say that would be interesting to the convention. There are others here who have had more time to look into the details of the system than I have had.

MR. SMITH (Allegheny City Light Company.): Mr. President, I would say that I have had some experience with the alternating system in the same company with which Mr. Duncan is connected, and also with another company in Philadelphia, where we started first with the direct system and changed it to the alternating. On some of the points on which Mr. Slattery has asked for information I may be able to satisfy him. We have found that where we are using the converter system its enormous flexibility enables you to apply almost any system of distribution you please. In one of our stations in Pittsburgh, where we rent lights in a poor neighborhood where the majority of places demand only three or four lamps, we found it cheaper to place the converters on the poles, running secondary mains and using either 50 volt or 100 volt lamps, as we pleased. In the other parts of the town, where we found buildings taking ten, fifteen or twenty lights, we found it better to take the high tension right into the building and place the converter in the cellar or the garret or on the outer wall. In some cases, we have a mixture of the systems. For watchmen's lights we have the secondary main outside and the converters directly in the building for the regular lights. In very large buildings we carried the high pressure mains over the building—that is, all through the building, and tapped to our converters wherever convenient. In the case of hotels, we have a high pressure wire down the center of the corridors, and in the case of a large parlor being lighted, we would put a converter in the corridor at that point. In the case of a row of bedrooms requiring twenty lights, we would put in a twenty light converter with secondary mains tapping the bedrooms on to these secondaries. Without the slightest trouble we change buildings having three or four hundred lights from one system to the other without cutting off the lights for a moment, by cutting up the existing wires into sections and tapping in the converters one after another as we need them. Whenever we wished to change a section we would substitute our 50 volt lamps for 100 volt lamps. When we had all the lamps changed in a building we would splice up where we had cut, as in a building having 300 lamps we only put in converter capacity for 200, knowing that no more than 200 lights would be burned at one time.

As regards the danger of shocks, I have had a little experience on both sides. I have had a full share of the arc light shock. I have opened circuit on 1,500 volts, which was sufficient for me. I have also taken 1,000 volts alternating, and there is no comparison between the shocks at all. If I may be allowed to give my own experience, I should say that the Thomson-Houston machine gives about the most tremendous blow I have ever felt. It is a peculiar dead stroke which you do not find in the Brush. But the alternating machine seems to throw you off instantly; you do not have time to take hold. We had a case in Philadelphia the other day which I think will be something for Mr. DeCamp to hear, as I believe he feared it was one of his men. We had been changing one of these buildings from direct to alternating, and while the building was still on the direct current one of our wire men went into the cellar and put an ordinary key socket on to the mains to give him light. After the building had been turned into alternating currents, one of these wires which had been used originally became a dead wire, and the lamp having been taken out of the socket there was nothing to show that current was passing through the wire. One of our men went down-stairs to make some changes, and our foreman cautioned him particularly to look out for those alternating current wires, as one of them was grounded. Two of the men went down together, and one of them, forgetting that the building had been changed to alternating, went feeling around to get hold of this socket. He found it, and he laid down on the wet ground, and the other man stumbled over him, and spoke to him, but received no answer. He spoke to him again, and stooped and looked at him, and finding that he was getting black in the face ran off to call for help. He ran down to the station, and while there learned that the foreman had gone to another building, and he ran after him The foreman told me that the moment he heard something was wrong there he knew what it was. He ran down in the cellar, and he found this man lying on his back perfectly still and blue in the face. He stooped down and shook him, and got a terrific shock himself. He saw that he still had hold of the socket, and he took his coat, so that he would not get the shock himself, and pulled the wire out of the man's hand, and then they picked him up. He had been then on the current, as near as we could estimate, four minutes, taking the full benefit of a thousand-volt current. The men did not know what to do, but fortunately they treated him for asphyxia. The man was blue in the face. They cut his clothes open and dashed water on him, and tried artificial respiration and in the meantime sent for an ambulance. By the time the ambulance got there he was sitting up, and refused to get into the ambulance, and seemed to be very much disgusted that an old arc light man like himself should be keeled over in that way by an alternating current of only 1,000 volts. The next day he expressed himself as perfectly well and ready to go to work. We had some difficulty in getting him to go and see the doctor, but we insisted on it, as we were more afraid of the nervous shock than anything else. The doctor told us that he was simply badly burned. The structure of the skin had been destroyed, as is usual in all electrical burns, and the burn had extended some distance, following two or three inches under the skin, and that was the real danger in the burn. He said if it was opened up the whole length he would recover with very little trouble. The man told us that for two minutes at least of the time he was on the wire he was perfectly conscious, that he knew his companion was there and he tried to tell him to pull the wire away, but he could not speak, and that when the man went away he knew perfectly well it was for assistance, and he then realized that it would be three or four minutes before they could get back, and he thought to himself that he could not stand it that length of time, and then forgot everything. He said that he felt

no particular pain. He got a shock that he would get from any electric current, when he first laid hold of it, but after that he felt nothing. The sensation seemed to be like that of drowning. As soon as we got him to gasp and breathe, his color came back again. This incident has given me quite a new hold on the alternating current system—to know that you can take 1,000 volts of it and stay on it that length of time. I know I should be very sorry to take a direct current one-quarter of that time.

As to the question of heating up machines, I would say that on the newer machines such as we are using now, we run them for a week, starting on Sunday afternoon and running until Sunday morning. The current runs from nothing—or an amount which you cannot read—to 35 or 40 amperes, and in all that time the machine never gets so hot that you cannot bear your hand on it with comfort. On the larger size machines we are using in Pittsburgh—we have one there that has been running two months—a 1,300 light machine. We only stop for ten minutes each day, and if the engineer does not feel like it he doesn't stop then. The load on that machine varies from nothing up to 65 or 70 amperes. You can always bear your hand on the machine, and as long as you can bear your hand on it, it is certainly not hot enough to injure any good insulation. The converters we know absolutely nothing about. We put them in and that is the end of it. I think we had to take two out on account of the blowing out of the plugs. The secondaries were short circuited, the effect of which is generally to blow out the primary plug. It does not injure the converter, as far as we have been able to find. We have never had a case of a converter short circuiting either in the primary or the secondary. We have occasionally had a converter terribly overloaded, when it will heat up and finally blow the plugs through another converter which is tapped in on the secondary wire having a poor connection. It is hard to get linemen to understand that where two converters are coupled together and one of them gets hot it is usually the other converter that is at fault. I am a little of an enthusiast on the subject of alternating currents, as in Pittsburgh we are using the direct system multiple arc and we have been struggling with 4 nought wire pulling our poles out of line and the direct current machines burning armatures. In Pittsburgh we put them to very severe duty, owing to the suddenness with which storms come up there. I have known the current in our station to jump from 300 to 2,000 amperes inside of 15 minutes. But comparing the two systems and taking into account the ease of distribution and the ease of handling, I say that the alternating system is bound to come, if for nothing else, for the enormous reduction it makes in the cost of running your station.

DR. MOSES: I am very well pleased to hear some of the details Mr. Smith has mentioned. I feel myself a little responsible for the success of that system, inasmuch as I then thought it would succeed, and now I want it to succeed. The alternating current machine, which I saw at Pittsburgh, was running very well, and had only been running for one month when I made that report to the last convention—as my neighbor facetiously remarks, that very extraordinary report. However, I have just returned from abroad, and thought that before coming here I could not spend two days necessary to get over the *mal de mer* better than in going to Pittsburgh and seeing how that machine was running. I am very happy to say that the same machine is running in that station in South Pittsburgh, that Mr. Smith speaks of, with this additional fact, that they have doubled up all around in their capacity—not doubling, however, that lone solitary man that Mr. Weeks saw there when he meandered through Pittsburgh and looked at the alternating current system. The same man was there. They had doubled up the capacity, but that same one man was running it, and I did not see that he had any more work to do than he had before. They were running 3,000 lights, where before they had been running 1,500. While wandering through Pittsburgh, and seeing thousands and tens of thousands of incandescent lights which they have about in all directions, I noted the progress that had been made by the principal company there engaged in the alternating current system, and I saw one thing there that I would like to call to the attention of this convention as being one of the most important things in connection with the development of alternating electric lighting that I have yet seen or heard of. When I went there six months ago they were making machines of 500 to 1,000 lights. The other day when I went up there I saw a 2,500 light machine running and doing its work admirably well, and here is the thing that is so remarkable that I will call special attention to. The machine simply seemed to have been looked at through glasses of gradual magnifying power; that is to say, the 500 light machine was of a certain size, the 1,000 light machine so much larger, and so on, but it was exactly the same machine in all its details. In a continuous current machine, if you want to vary the output of the machine by increasing the parts, you will find yourself, when you begin your work, quite at sea. No one can calculate exactly what he is going to get at. True, there is a good deal of pleasure in guessing right, but if you do not happen to guess right it is very disagreeable and costly. But here in the alternating current machine you see a possibility, under certain forms of the machine, of quadrupling the output without changing the form of the machine at all. Now where is that going to stop? It is only a step to say that they will be making some day, in the simplest manner, 10,000 light machines that will require no more attention than the same solitary man that we saw at the South Pittsburgh station. The strength of the materials is the only limit to the length of the shaft bearing the armature, and I do not see really where the limit is going to be; so if you want to put in central station work it seems to me that on an alternating current machine you may do an unlimited amount of work, and get rid of all this great trouble you have had in doubling up machines, looking after commutators and all that difficulty, which naturally limits the aid of a plant. This is a fact that I think will be of value to the convention, and I give it.

MR. KIMBALL: In regard to the alternating system of supplying incandescent lights, since the last convention in Philadelphia there has been a marked advance, and from the various installations which are at present in operation we have been able to get data which are interesting and valuable, and the question of insulation on the high potential wires is one which appeals to all in every part of electric lighting stations, whether in the lineman or the central station general manager. To one it is danger to his own life and limb, and in the other may be destructive to property. Regarding the danger of carrying high potential wires into cellars, there are many cases where it is convenient, instead of putting a converter high up on a fixture at the top of a tall building in a city where there is no pole line, to place the converters in basements and run the high tension wires to them. It is very expensive to put a converter for 100 lights on top of a man's building, and carry such a wire as a No. 0 or 00 down into a basement to distribute the incandescent light, instead of coming up through the floor, and if a way can be devised for enabling us to carry safely the currents which, to say the least, approach the intensity of the arc current into our cellars without a sense of danger, it is a great achievement. The insulation between the primary and the secondary conductors in the use of the induction coil is one which is affected by a variety of causes. Where converters are placed out of doors, and air spaces left for ventilation in the covers, moisture will get in, and grounds will develop on the high tension wires; not from defective wiring, as far as relative insulation in positive and negative wire is concerned, but leaks to earth, which will develop in case of an external ground on the high tension wire. The solution of the problem is to adopt the bold expedient of grounding one side of all inside wiring by heavy metallic lines to the earth. This has been brought to the attention of this convention before, and has been published in some of the electrical papers, and it seems to me should open a field for discussion. The fact must be appreciated that each system of incandescent wiring from a converter inside a building is entirely separate and completely isolated from every other piece of wiring in the city or town, and that running such a metallic ground from one wire to the earth is not to be compared with grounding, say the positive conductor in the usual system of a distribution system of ordinary incandescent lighting where the positive conductors are connected together all over the city. In such cases should danger develop, the ground being only on one wire, the lead fuse can give way to an excess of current from short circuit, and either positive or negative in case of bad conver er without in any way affecting the other installations, and in such way give warning of danger, whether in the converter or in defective wiring, and should the system be in perfect condition have no influence whatever.

Regarding the distribution of currents over a large area, in disucssing a system of running incandescent lights which requires us to use a little different apparatus, it seems to me that those of us who have the practical work to do are apt to lose sight of the fact that all the laws of wire and construction work which apply to straight incandescent or low tension wiring are applicable to the alternating system, and that all appliances which are made for straight incandescent work may be utilized for the alternating current by conforming to the laws which are now so well known regarding self-induction and the closed magnetic field, but a question to be decided by the electric light engineers is whether it is better to rely on high potential wires for a system of distribution and lay them out with as much care as the feeders and mains are now laid out in low tension distribution, and then to place the converters as near the lamps as possible where they may be required; or whether it is better to run a plainer system of high potential mains and rely on your secondary wiring for your equalization of potentials. By secondary wiring I had in mind the secondary circuits from converters to lamps. In many plants converters are placed in groups, not necessarily near together, but connected by a main trunk secondary wire, which is practically the same as the mains in a continuous current system of distribution, so that part of the advantages of the alternating system is lost in carrying the heavy wires such a large proportion of the distance to the lamp from the dynamo, by an addition to the high potential wires, having to run a complete set of secondary mains as well.

In the example which our friend Mr. Slattery gave of the 400-light lamp taken from rough figures, which I have in a note book only, it seems to me that I should arrive at a rather different result in this direction as the problem, as it was given and I understood it, was 400 lights, 16 candle power lamps, a mile and a half from the source of generation to the center of distribution, which it was suggested would require a No. 2 Brown & Sharp wire, and with that number having five per cent. loss. It may be that two methods of arriving at a result will introduce errors, which hardly ought to be as great as this; for assuming five per cent. loss from the source of generation to the center of distribution, and something like four or five per cent., I believe, was mentioned for loss in the converters, independent of inside wiring, calling it a round ten per cent.; 400 lights, and the lamps in more common use are something like a 50 volt lamp—400 lamps representing 20,000 watts to be delivered from the dynamo, and with the addition of 200 watts for loss would give us 22,000 watts, divided by the potential of the dynamo, giving us 22 amperes to be carried through this distance of three miles and allowing our five per cent. drop—5 per cent. of 1,000 volts being 50 volts—we have 50 volts lost. The 22 ampere current to be carried, and the volts divided by the current gives us the resistance of 45.10 ohms, which could be used in the line, and for three miles of No. 5 wire, which would, roughly, allow us 4.5 ohms—the wire having the loss of $\frac{5}{10}$ ohms per thousand feet, or about a No. 5 wire, with a loss of 5 per cent.

MR. DECAMP: In the report read by Mr. Slattery, he speaks more positively about the difficulty of insulating for this current. On the other hand, he notes that the effect of the current upon a person—and he is corroborated in this by Mr. Smith—is not so great as it is on the direct current. That struck me as being a little inconsistent. The electromotive force, as I understand it, is a very strong element to guard against in making installations. It is what affects the human body. I would like to have an explanation of that.

There is another thing I would like to know. The peculiarity of this current is such that the close contact is going to effect the currents or going to affect the insulation, making it more or less difficult to insulate. As an explanation of why I want to know that, I would say that we are about to run an alternating circuit underground in the city of Philadelphia through an iron conduit. Those are things we have got to contend with. Now, shall we make that conductor of an insulation that requires a second metallic covering such as lead? Do we lessen or do we increase our difficulties by so doing?

MR. SLATTERY: Right upon that point, before we give any of the other matters that were brought forward for consideration, I would beg to refer to Messrs. Westinghouse, who are in that line, and who can render us some valuable information with regard to these special methods of insulation, and I defer to them as having a far greater experience in that direction than I have myself. If they will be kind enough to render the information which there is no doubt they are in possession of with regard to the disposition of such a circuit, I should be greatly gratified myself.

MR. SMITH (Allegheny County Light Company): I would state that I am not in any way a representative of the Westinghouse people, though using their apparatus; but being in the same city as their manufactory, I have had exceptionally good opportunities for observing their work. In Philadelphia we are using lead-covered cables. We use that because it seemed to us that in underground work the first thing we had to look out for was moisture. We satisfied ourselves that if we could get a good metallic covering, it would be probably about as good as anything we could get hold of. Our conduit in Philadelphia is made of a common pine box, in which the cable is laid, and the box is filled with pitch. In that we have iron junction boxes for connecting our feeders into our mains. The outside covering of the cable is not insulated in any way from the junction box, though, of course, the wire carrying the current is. In some parts of the street where we found it difficult, owing to water pipes, the cable car conduits, etc., to lay a wooden box, we used iron pipe, through which we pulled these cables, and then filled them up with pitch. We filled them up with pitch simply as a mechanical protection to prevent workmen from hammering a pick into them. We have not had the slightest trouble or loss of current or induction or anything else. Our men handle the outer covering of this cable with perfect impunity, and, as long as your dielectric is in good shape, it seems to me you have something that is perfectly safe. I understand that some experiments have been made by the Westinghouse Company with regard to this very question, and when I put to them the question their answer was that we could use any kind of cable we wanted to as long as the covering was good, but for practical use they would recommend to us in this particular instance a lead-covered cable having both conductors in the one covering; that is to say, two separate cables soldered together through their whole length, and that is the form of cable I have

been advocating myself, for mechanical reasons. They made the test for me. They tested it thoroughly in every way, and told me I would get perfect satisfaction out of it. When we turned the alternating current into our Philadelphia lead-covered cable, where the cables are run in separate boxes, but grounded throughout their whole length, the question was raised whether static charges would not come into effect, and our men get shocks; but we did not find that there was any effect whatever. As to the question of loss of power through induction passing through a metallic covering, it might be different with iron. As I say, I have had no experience with long conduits of iron; but it seems to me that if you run your wires close together, that any effect you get on one wire, when it is positive, would be neutralized by the other being negative at the same instant. In the same way with telephone wires. We have found that if we cross our wires every four or five poles, we have no effect whatever in the telephone. In one case we have the double circuit, about twelve inches apart, and the telephone wire running on top of the pole, about seven inches between each wire. There is a continuous musical note, but not nearly as annoying as the buzzing of an ordinary arc machine. We, of course, think that the telephone companies ought to cross their wires, as we do not think we ought to be called upon to be public benefactors to such an extent. Mr. DeCamp raised another point. I have forgotten it for the moment.

MR. DECAMP: On the question of the consistency of the statement that the ——

MR. SMITH: Oh, yes. As regards that, of course, I have only practical experience. The 50-volt alternating current you cannot feel. On the larger machines we are using, the discharge is not so heavy. You take an ordinary arc-light machine, and you have this immense mass of iron in the field magnet, and when you open the circuit, you discharge the field magnet into the line. That is the reason, I think, that the Thomson-Houston machine gives so much heavier blow than any other. I have taken these discharges from the field magnets from an ordinary incandescent machine. It is a dead blow, and there is a large quantity of electricity discharged at once; but in the armature of the ordinary alternating machine there is so little wire in it that not much harm is done. We never think of shutting down the machine for the linemen to splice up. They climb up the poles, and make the connection on live wires. They say they would sooner splice on our lines than on a Brush machine. We have had no case of the men being hurt with it at all. We had one of our men short-circuit a thousand volts on our switchboards with his plyers. It scared him badly, and burnt the plyers; but it did not damage either the machine or the man.

THE PRESIDENT: This discussion has taken a pretty wide range. What disposition will you make of the paper read by Mr. Slattery?

MR. SLATTERY: May I be permitted to say one word more? I would say simply that I believe the object of this report has been creditably obtained, in consequence of the very valuable information elicited from the companies who take a large interest and care in the introduction of this induction business throughout the country. It is extremely gratifying, too, the candid spirit in which the information is rendered. It is almost magnanimous in the manner in which it is given, and I cannot express my appreciation of it in too strong terms. Our friend Dr. Moses again has placed another future before us. He has given us apparently impossible problems to work out; but he has a singular prescience in his treatment of these matters, and I believe that the immediate future will show the realization of these apparently impossible accomplishments, as they have ably shown the accomplishment of apparently impossible things that in the past he has stated would be done. A gentleman at the end made the statement about some miscalculation of a wire, and aired his erudition in that direction very creditably, indeed. He debited me with the statement of a ten or fifteen per cent. loss in the circuit. I am not aware of stating any such loss in the induction system, and on reference to my paper he will be enlightened in that direction. The figures I gave there were simply approximate ones in regard to cost simply, and the loss that I stated was involved in consequence of using conductors, and the loss that he stated, was entirely different—the calculations that led him to perform his mathematical gymnastics.

I have to again express my great appreciation of the manner in which our report has been accepted by this convention, and I know that I shall receive very great encouragement myself for future efforts in this direction in conjunction with our worthy and excellent opponents. (Applause.)

MR. KINSMAN: Since I came in I heard one or two gentlemen speak of the information they cared to supply in regard to this alternating system. I would like to add one thing that may be of interest. I have succeeded perfectly in burning an arc light with a 50 volt converter from the alternating system of the Westinghouse people. We get 12 hours from 24 pieces of carbon and a light that is perfectly steady.

MR. KIMBALL: Mr. President and gentlemen of the association: I wish to say that I owe Mr. Slattery an apology. In attempting to follow the speaker I made a mistake which a better exercise of judgment would have prevented me from committing. I relied on figures that were scribbled on a piece of paper picked up from the floor and roughed over with dirt. The resistance of line should be $2\frac{3}{16}$ and a No. 2 wire, and I beg Mr. Slattery's pardon, as his calculations are correct.

MR. SLATTERY: I beg to accept your very graceful apology, sir. The per cent. of loss I stated in the paper I think was 4.

MR. SMITH (Allegheny County Light Company): I would like to ask Mr. Kinsman what is the style of the arc lamp?

MR. KINSMAN: It was the Simplex lamp 2,000 candle, 55 volts.

MR. GARRATT: I move that the paper be accepted. Carried.

THE PRESIDENT: The next paper is that of Mr. E. R. Weeks, of Kansas City, Missouri, on "Electrical Education."

"ELECTRICAL EDUCATION."

By Edwin Ruthven Weeks.

Few questions of the day are so important as the applications of electricity, and there are none upon which exist such a lack of general information.

The telegraph business is so extensive that people think no more of sending a telegram than of posting a letter; we are beginning to depend upon the telephone as an every-day necessity; the electric railway has demonstrated its financial basis; and the electric light, though a creation of yesterday, is so largely used, that about two hundred millions of dollars are invested in its manufacture in America alone. In fact, so many are the practical every-day uses to which electricity is put, that we have not time to enumerate them. Yet the public has more knowledge of almost any other instrument of its convenience, than of this one force that first inspired the fear and curiosity of man. Not only is the general public almost wholly ignorant of the principles, uses and modes of application of electricity, but there has been such a scarcity of those who have made a special study of these new branches of industry, that it has been well nigh impossible to secure the intelligent service that many of them require. A man of average education may easily gain the mechanical dexterity, the sensitive hearing, and the rapidity of thought necessary for telegraph and telephone service; but some applications of electricity require thorough special training for efficient work, and we cannot hope for satisfactory service in the direction of traction and lighting till this training is furnished.

Electrical engineering is undoubtedly the occupation of the future for the young man who does not care to enter the already overcrowded professions but whose education fits him for a broader field than that of the trades. It holds out the highest inducements financially, and it is a service in which the intellect can never rust out, as it offers a continually widening horizon of thought; indeed, the possibilities of this profession are as yet practically unlimited. In most fields of labor the best has been accomplished; here the work is in its infancy, and the demand is not only for skilled hands, but for trained and progressive minds. The property involved in the applications of electricity is already immense and is rapidly increasing; much of the machinery used is most delicate—no unskilled hands should destroy its value or make it render less than its best service. "Electricians" to whom Ohm's law is "Greek," and "experts" who "adjust" but never clean, should not be allowed to multiply.

But how can the special education, which shall produce true experts and electrical engineers, be obtained? Several colleges have given this department some consideration, but not so much as it deserves. Its training should be both theoretical and practical. A thorough understanding of the theory of electricity is absolutely necessary to enable one to keep pace with the rapid progress in this branch of applied science; and without an intimate knowledge of the apparatus used, commercial success is impossible. Colleges and universities should have well equipped laboratories, and should add to their curricula complete courses in electrical engineering, laid out after consultation with those few eminent electricians who have had experience in the class room, the laboratory, the factory, the station, and who know better than any school recluse what theoretical training is of value.

To receive the greatest benefit from such special courses, it would be well for the young man, after completing a thorough basic high school course, to spend some months in an electrical station doing the practical, every-day work there required; and thus gaining a more nearly adequate idea of the information he will need to give him skilled control of the forces with which he is to deal. With this preparation, he will be enabled to take hold of the theoretical work with a zest that can come only from an understanding of what it is to do for him and what he is to do for himself. Having finished his college course, he is not yet to consider himself a graduated expert, but some time spent as a learner in factories and stations should be a regular part of his electrical education.

After fully carrying out such a plan, the young man will be in possession of a theoretical and practical knowledge of the work he has chosen, that will give him access to the most desirable of positions.

The more complicated electrical industries are of such recent date, and their growth has been so rapid, that school-trained workmen could not be obtained. Schools had not time to adapt themselves to the new order of things Only unskilled labor could be employed, and only such can be had for some time to come. Much of this work has been performed by uneducated men, many of whom have shown that good results may be accomplished without school training or higher mathematics. Thoughtful observation and practical experience have done well for them, but always at the expense of costly mistakes and delays; and at best, such labor is limited in its possibilities. Only the trained mind can attain the highest places.

But something should be done to assist the vast army of halting hands that in the near future—nay, in the very present—must do the work, while the schools are preparing for this new field of labor. Ours is not an industry with long years of experience to draw upon, yet it is one in which the unexpected, the unprovided for, is constantly occurring. Therefore, interchange and comparison of thought and experience are more necessary here than in other industries of greater age or slower growth. Had this been fully realized in the earlier history of electricity, much of the bungling work of the past might have been avoided; for there can be no doubt that the progress in intelligent service has been greatly retarded by the narrow policy which refused to impart information to the "new man," but which is giving way before the broader influence of our associations. Members of the electrical fraternity are beginning to recognize the truth that knowledge given away is the more securely possessed; and that as all know more than one, all may be benefited by an interchange of ideas and employers are awakening to the fact that they must also be educators.

In order that the skill and intelligence of the worker may in some wise keep pace with the rapid progress of electrical invention, every mode of improvement should be employed. The public should be informed upon these subjects and led to take an interest in them. Young men must learn that there is a new, broad and remunerative field of honorable and attractive service.

The National Electric Light Association is doing much, and should do more, not only for the mutual advancement of its members, but to bring the business which it represents before the public in an intelligent way, not at all as an advertisement, but because it is safer, pleasanter and more profitable to serve a people well informed upon our work than one whose fears are multiplied through ignorance. The Edison Association and the Institute of Electrical Engineers are also exerting an influence in an educational way, and the clubs that are springing up in all electrical centers cannot fail to accomplish a good work in the same direction.

But such organizations, however valuable they may be, can affect but indirectly the large body of men who handle machines and lamps, run lines, or serve in any of the branches of a business that needs intelligence even in its firemen. Yet these are the men upon whom the success of the new industry must largely depend.

As intelligent service is the most profitable, employers can afford to spare no expense to obtain it. Every station should possess a pleasant reading room well stocked with papers, magazines, and standard books on electrical and kindred subjects, and employes should be made to feel it a part of their daily duty to inform themselves upon all matters connected with their work. From time to time they should be questioned upon important points; and if they cannot be led to do the necessary reading in any other way, they might have monthly grades and ranks determined by the information they have gained from their work in the reading room. All large stations should have mutual improvement societies of its men, furthered and assisted in a personal way by employers, in which the problems of daily work may be discussed, and directions given for useful and telling study by employers who do not well know how to help themselves.

Municipalities should appoint boards of examiners whose duty it should be to inquire into the competency of electrical employers, especially those of light and power companies, as ignorance and poor workmanship here endanger both life and property. Line and station foremen should be licensed, as their duties are fully as responsible as are those of stationary engineers.

By such legal measures, faulty construction will be prevented, and cities will secure safe and efficient service for the public; will further the interests of workmen; will protect electrical investments, and assist in the education of the people.

MR. DECAMP: I move that the paper be accepted and spread on the minutes of the association.

The motion was carried.

MR. SMITH (Jameston, N. Y.): I would like to ask if Mr. Weeks could recommend to the convention any practical text books which could be put in the hands of linemen for use in their every-day duties.

MR. WEEKS, Yes, sir: I think there are a number of books which are sufficiently popular in their style to be of great use to employes. We have a society of our employes in Kansas City on that plan that I have pointed out here, and we have made it a complete success. I think that if Mr. Smith will get a list of electrical works from any one of the electrical papers, that he will be able to select from 30 to 40 books, sufficiently simple and elementary to form a nucleus for a library of this kind.

MR. GARRATT: I would say in that connection that I found a little work by Sylvanus Thompson, known as "Elementary Lessons in Magnetism and Electricity." It is a very valuable little work and an inexpensive one, and contains enough material to keep the average workman busy for a long time.

MR. MASON: Is a motion in order at this time, sir?

THE PRESIDENT: Yes, sir.

MR. MASON: There is handed me, sir, the following resolution, which I have been requested to read. I will read the resolution and append another:

RESOLVED, That the work that was assigned to the committee on insulation and installation is of such importance that this convention cannot allow the subject to escape their earnest attention; that the subject is of the utmost importance to the electric lighting interests and one in which there must be abundant material and experience which can be obtained without expense to this association, and further that another committee should be at once appointed to gather information, classify the facts and then offer them to the convention in form that may be of practical as well as of scientific advantage.

I add this resolution; sir:

RESOLVED, That a committee of five on insulation and installation be appointed to report at the next meeting, and that Doctor Otto Moses be the chairman of this committee.

I do not see the necessity of this second part beginning "that the subject is of the utmost importance." If I may, I will omit that.

The first resolution was then adopted.

DR. MOSES: That is a very high compliment paid by Mr. Mason, and I must beg to decline.

MR. MASON: Does Dr. Moses refuse to serve on such a committee?

DR. MOSES: I do not refuse to serve, but I refuse to be the standard bearer when others are more competent than myself.

THE PRESIDENT: That shows a degree of modesty that does the gentleman infinite credit.

MR. MASON: That is entirely unexpected. (Laughter). I stated that, Mr. President, because I did not think you would allow any such declination.

THE PRESIDENT: Mr. Mason, you present a resolution that a committee of five be appointed?

MR. MASON: Yes, sir.

THE PRESIDENT: I find you retain Dr. Moses in the resolution.

MR. MASON: It does not lie with me to accept his resignation.

THE PRESIDENT: He has not been appointed yet.

The motion to appoint a committee of five was then carried

THE PRESIDENT: I will appoint the committee, and I will endeavor to induce Dr. Moses to serve on the committee, if not as chairman, as one of its members.

With Col. Leggett's consent I will place him on the Committee on Revision of the By-Laws. There are two points which he made this morning, and which I concede to be of the greatest importance; first, that the convention should decide where the next meeting of the association should be held; next, that they should elect for president of the association some one in the locality selected for the meeting, believing that rotation in office is a good thing. I have passed the time when I am seeking particularly after glory, and would be very glad to resign the glory and labor to some more competent hands. In making up these by-laws I think it would be well to consider that part of the ition. The business of the association can be better handled if the president of the association is chosen from the location in which you intend to hold your next meeting. I assume, Col. Leggett, that you will serve on that committee.

MR. LEGGETT: I think, inasmuch as I was cut off in my remarks this morning, that it would be fair for me to say that, as far as I am aware, there could have been no better service rendered to our association than has been rendered by our present officers, and especially our present chairman; but it seems to me that it is a matter of considerable importance that these officers should be rotated for the special reason which has just been mentioned by the chairman. The meeting in a certain locality ought to carry with it as nearly as practicable the election for that year at least of the officers of the association in the same immediate vicinity; and then again we might, at some period, be burdened with certain officers whom we do not like, and through a sentimentality which might grow up in this way, be burdened in a manner which we might not care to relieve ourselves of; while I am very happy to say, and I know I reflect the sentiments of every member of our society, that the present officers have served us with great ability; but I think that that could be made a part of the constitutional groundwork of our association, in order that no difficulty may arise, or no embarrassment arise hereafter in the organization of our society or in its meetings. It was my purpose in speaking this morning to suggest that it be made an element of our by-laws, of our constitution in fact, that the position of president and vice-president—I think it ought not to apply to the secretary and treasurer because their duties are of such a character that they may properly with great benefit be maintained in the same hands for a considerable period—but that the offices of president and vice-president—that nobody be eligible to those offices for two successive terms.

MR. MASON: How can we have another election when we had one six months ago, and the present officers were elected for a year?

MR. LEGGETT: I find no difficulty whatever in that, sir.

THE PRESIDENT: None whatever, sir. The present president will relieve you of that difficulty before the end of the present session. I think it would be well to suggest in that connection at this stage that the Committee on Nomination and the naming of the next convention be appointed now, so that during to-day and the next two days they will be able to canvass that question thoroughly, and suggest on the last day of the convention a proper place and the names of officers for the next meeting. To relieve them of any embarrassment, I shall, as soon as that committee is appointed, tender you my resignation as president of the association. That is done so as to facilitate the work we are engaged in now.

MR. LEGGETT: I want to add in that respect that this same matter was talked over by our present chairman and myself prior to the meeting in Detroit, and it was his own suggestion and desire that that should be the course of our convention.

THE PRESIDENT: A thorough discussion of this question took place between Mr. Leggett and myself, and I believe it is better that the officers of the association should be subjected to some system of rotation. There is an honor connected with the holding of the office of president at least, and we all should be eager to fill that office. I have served my time over and over again, and I would be very glad to hand the gavel to somebody else next year. I hope some gentleman will suggest a Committee on Nominations and place of meeting.

MR. MAILLOUX: I move that a committee be appointed by the chair for that purpose.

The motion was carried.

THE PRESIDENT: It will not take you long to get acquainted. I hope the gentleman will not press his resignation.

MR. MAILLOUX: Very well, sir.

THE PRESIDENT: The chair is now pre-

THE PRESIDENT: How many shall that committee consist of?

MR. MAILLOUX: I think that ought to be left to the discretion of the chair.

THE PRESIDENT: I will name Mr. Mailloux, Mr. Leggett, Mr. Robinson, Dr. Moses and Mr. DeCamp.

MR. EUSTIS: I would like to ask for information on one point, and that is, that, as I understand it, the election of officers is held once a year. Now the discussion has been on the subject of electing a presiding officer in the locality where the meeting of the convention will next be held. That same officer will hold office for two meetings. I believe the general practice of the convention has been to vary its place of meeting over different sections of the country. Now that same officer is going to hold his office for two meetings.

THE PRESIDENT: In the new constitution provision can be made to meet that point, so that you can have your elections semi-annually instead of annually.

MR MAILLOUX: I beg to resign from the committee, my reason being that I am not perhaps well acquainted with the gentlemen who would be eligible for positions as officers; there are many other members of the society who know the prominent members thereof, who would be more fitted for a position on that committee.

prepared to entertain a motion to adjourn until an hour to-morrow morning.

On motion of Mr. DeCamp, the convention adjourned until 10 A.M. the following day.

WEDNESDAY'S SESSION.

The convention was called to order at 10.30 A. M., on August 10, by Mr. Ralph W. Pope.

MR. POPE: I have been requested to call the meeting to order in the absence of the vice-president, and it will be proper for you to nominate a temporary chairman to conduct the business of the meeting.

MR. FRANK RIDLON was chosen and took his seat as temporary chairman.

LIEUTENANT MURDOCK read a paper on electric light for the new cruisers.

THE ELECTRIC LIGHT OUTFIT OF THE NEW CRUISERS.

BY LIEUT. J. B. MURDOCK, U. S. NAVY, ELECTRICIAN, TORPEDO STATION, NEWPORT, R. I.

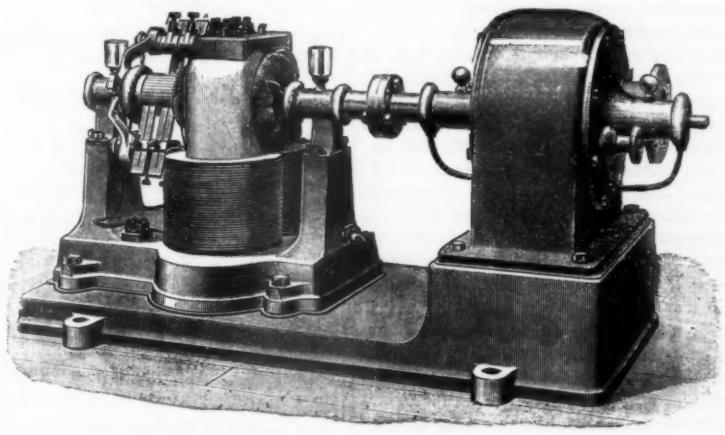
The question of how to best install the electric lights in the new men-of-war has been considered in detail, and it seemed advisable to bring the matter before the National Electric Light Association, that the manufacturers of the country might have the problem presented to their consideration in advance of the time when they would be asked to act upon it. In conversation with managers of various companies, it has been impressed on my mind that the peculiar conditions existing on shipboard are but imperfectly, understood and as a natural consequence they have not as yet been as satisfactorily met in this country as abroad. I am confident that American ingenuity and skill can fully meet our requirements, and hope that the number of dynamos, about sixty, which will be needed for the vessels already authorized by Congress, may be considered as meriting the experiments necessary for their successful installation.

I am authorized to present in a general way the views of the Bureau of Ordnance of the Navy Department, on the peculiar conditions to be met, and on the best method of meeting them.

In men-of-war the prime requirements of all kinds of apparatus are compactness and lightness. Neither of these is of any material consequence in electric light installations on shore, and both are generally ignored. Attention has there been given mainly to the question of efficiency of conversion, and a glance at the advertising columns of any of the electrical journals shows that the maximum efficiency and best system of electric lighting is possessed by each of a dozen companies. Our conditions, so far as the dynamo is concerned, may be summarized as wishing the greatest electrical output for a given weight and bulk, and although at first thought this may seem to be essentially the same thing as efficiency of conversion, it is widely different.

The following figures of well-known American dynamos illustrate this point. The comparison is made on the basis of "watts of output per pound of dynamo." The weight, speed and electrical output have been obtained in general from the manufacturers, and are given of course only approximately. In this comparison it is of course necessary to consider also the sizes and the number of revolutions, the watts per pound increasing with large machines and high velocities:

DYNAMO.	Revolutions.	Watts in External Circuit.	Watts per Pound.
Edison, No. 20	800	50000	6.0
Brush, H. 3	850	66000	9.4
American, 50 Light Arc	875	21600	5.7
Westinghouse, No. 18	900	30000	5.4
Hochhausen, No 8	1000	35200	8.8
Mather, 500 Lights	1050	35250	7.4
Weston, 6 W. I	1050	11500	4.1
Brush, G. 4	1050	28800	9.3
American, 15 Light Arc	1075	6480	4.8
Weston, 7 W. I	1100	20125	6.5
Westinghouse, No. 12	1100	18000	4.
Brush, F. 5	1100	19000	8.5
Thomson-Houston, H. I	1150	25600	6.1
Edison, No. 12	1200	30000	6.9
Hochhausen, No. 6	1200	17600	8.
Thomson-Houston, E. I	1250	18200	5.8
Mather, 400 Lights	1300	28100	7.0
Edison, No. 8	1400	20000	6.9
Thomson-Houston, C. I	1500	6000	5.6



TURBINE WHEEL AND DYNAMO COUPLED DIRECT.—SEE PAGE 6.

The next consideration is that of the connection of the dynamo to its engine. A starting point is afforded in the rule that belting should never be used on a sea going vessel. Nothing so radically violates our condition of economy of space as the use of belting. When space is saved by the use of a short belt, the working conditions are comparatively unsatisfactory. Belts are liable to be thrown off by the sudden changes of load to which our dynamos are subject, and become a source of danger to the attendants, if the ship is rolling heavily. The adoption of friction gearing between engine and dynamo has been suggested, and is probably practicable; but its durability on shipboard, where the motion of the vessel must cause working of the two shafts, may not be great. In the navies of Europe, the practice of direct connection is universal, the dynamo shaft being coupled to that of the engine. This calls, of course, for either a great reduction of the speed of the dynamo or a corresponding increase of that of the engine. It is easy enough to procure an engine running 1,500 revolutions per minute; but it is a very different matter to find one which will govern satisfactorily at so high a speed. So far as I can ascertain, there is no automatic engine manufactured in the United States, capable of indicating thirty horse power, which is designed for a higher speed than four hundred. I have been informed, however, that some of the types now in the market could be modified so as to operate well at five hundred. I am not aware of any dynamo in the United States absorbing thirty horse power, which would yield its normal output at even the higher speed. It is much easier to reduce the speed of the dynamo while preserving its electrical output than to raise the speed of the engine. Admitting the desirability of direct connection on shipboard, the problem proposed is the best method of obtaining the same output in watts per pound, at a speed below

500, that is now commonly obtained between 1,000 and 1,500.

The following figures of European dynamos, obtained in the same way as those already given for American machines, and probably equally accurate, will show how this problem has been met abroad:

Dynamo.	Revolutions.	Watts in External Circuits.	Watts per Pound.
Manchester, No. 6	350	9000	3.6
Victoria, H. 3	350	36000	9.7
Siemens & Halske	350	16000	8.1
Edison-Hopkinson, 10 in L	350	16800	2.9
Manchester, No. 7	400	22500	4 6
Victoria, F. 3	400	21600	8.6
Siemens & Halske	400	20000	10.2
Edison-Hopkinson 15 in S	420	39600	3.4
Gramme, H. 2 d 225	450	23600	8.3
Elwell-Parker	450	50000	5.6
Crompton, $\frac{40}{11 0}$J	460	45100	6.7
Edison-Hopkinson 8 in L	525	15400	3.3
Manchester, No. 5	525	6500	4 7
Crompton $\frac{32}{11}$J	550	24750	6.0
Manchester, No 6 A	550	25000	6.75
Edison-Hopkinson, 10 in L	550	25200	4.4
Victoria, D. 2 S	600	8400	6.7
Gramme, H. I. c 200	600	14000	6.4
Ganz	670	50400	9.2
Crompton, $\frac{60}{11 0}$J	675	66000	9.8
Goolden-Trotter	765	16000	6.2

It is necessary to only refer incidentally to a few of the methods by which these results have been obtained. The principal are the elimination of all iron not needed for the magnetic circuit of the dynamo, and the adoption of a type in which this circuit furnishes a framework of necessary rigidity. The maguet cores should be of the best wrought-iron, this single condition frequently reducing the weight twenty-five per cent., while preserving the output. Armatures of large diameter give high peripheral velocity at low speed, and this seems to recommend the Gramme ring, a large drum armature being cumbersome. The Gramme form has another advantage for ship's use, that it can be repaired or even rewound with the facilities existing on shipboard, although I believe a Siemens winding has recently been perfected, which admits of equal facility of repairs. The use of multipolar machines contributes to lightness, and the Siemens and Halske machine referred to in the preceding table has four field magnets inside a Gramme ring. Flattened ring armatures and multipolar magnets also give large output for the weight.

Every ship, aboard which the electric light is a necessity, should have two similar dynamos, that either may be used at will. At present this precaution is not observed in the navy. The lighting of the ship by incandescent lamps is under the control of the Bureau of Navigation, and the installation for this purpose consists of an ordinary plant of an engine driving a dynamo by belting. The electric search lights, two of which are furnished to each large vessel, are supplied by the Bureau of Ordnance, the installation for this purpose consisting of a Brotherhood engine driving two C. Grammes connected direct on the same bed plate. In case of accident, the incandescent dynamo will not work the search lights to advantage, nor will the Grammes operate the incandescent lights well. This is, of course, most unsatisfactory, and the need of the service is for a dynamo which will perform either work well, and, if necessary, both at once. Our search lights require about fifty volts and fifty amperes for ordinary work, the current being sometimes increased to one hundred. The lamp is operated by hand in order to fully utilize the radiation from the crater of the positive carbon The hand lamp and Mangin projector are in use in nearly every navy in the world, for projecting a condensed beam of light to a distance. Automatic lamps do not admit of continuous adjustment as readily as the hand lamp, and are not so thoroughly under the control of the operator. In any search lights the arc may sometimes fail, and it is sometimes advisable to cut the lights out without notice. Large and sudden variations of load are thus liable to occur, and these should not affect the dynamo. It is unquestionable that incandescent lights can be worked from a series dynamo, and search lights operated by a shunt machine, but most of these proceedings are makeshifts. It is undeniable that both search lights and incandescent lights can be worked satisfactorily by a compound dynamo. I have been called upon to work all these kinds of dynamos for each purpose, and the compound dynamo works incandescent lights as well as a shunt machine, and search lights better then does the series machine supplied for the purpose. I have also worked two search lights and fifty incandescent lights simultaneously from one compound dynamo. Each search light had three-tenths of an ohm dead resistance in circuit to bring the difference of potential down to about fifty volts. There is nothing new in this, but I have so frequently been asked what advantage the compound dynamo possessed, that I have trespassed somewhat on the time of the convention to give reasons for the opinion that all naval dynamos should be compound wound for a constant potential.

It is probable that many of our new vessels will require electric motors. Some of our gun carriages may be worked in this way, on account of the advantages that an electric motor offers in small weight and bulk, and in the important fact that it is so much easier to splice a broken main than to patch a leaky pipe when steam or compressed air is used for power. Electric motors will be useful for shell hoists and ammunition whips, reducing the number of men employed for these purposes. Here, also, light weight and compactness are absolutely essential, and nine-tenths of the motors in commercial use would be barred out as too heavy. A ten-horse power motor, the largest we would probably use, should not weigh over five hundred pounds.

The potential at which the mains should be kept must be determined from the relative importance of the three uses to which our dynamos will be put. As we are not bothered by the question of long distance transmission, we can well use a low potential for incandescent lights and motors, while search lights require only fifty volts, although it is advantageous with any dynamo to have a little dead resistance in the search light circuit. For these reasons I think seventy volts is about the best point for a compromise. This is the voltage used in the French navy, the English working at eighty. If two search-lights can be successfully worked in series, the potential at the dynamo might advantageously be raised to one hundred and ten, or even one hundred and twenty volts. Experiments have been made to test this point, but it is not decided as yet. Should there, however, be any material advantage secured in the working of either incandescent lights or motors by the use of a high potential, the search-lights could be operated with sufficient resistance to give them their proper potential.

The same requirements of small bulk and weight must control in the choice of engines. The adoption of a compound dynamo throws extra responsibility on the engine, as without constant speed the advantages of the dynamo are not apparent. American automatic engines can easily meet this demand, but most of them are too heavy, rigidity of frame being secured by the use of unnecessarily large masses of cast-iron. One hundred pounds weight per indicated horse power, with 80 lbs. steam, is a liberal allowance. In many European engines, steel and phosphor bronze have been largely used to obtain lightness.

It may be interesting to compare a few well-known dynamos as to compactness, the comparison being made on watts of output per square inch of floor space.

It is noticeable abroad that, with the type of slow-speed dynamos established in the markets, the system of direct connection is adopted in many isolated plants on shore. The tendency throughout Europe is to reduce the speed of dynamos, preserving the electrical output by a careful study of details. Few recent machines built abroad are designed for higher speeds than 800, while an American company, operating at and above 850, advertises slow speed as one of the advantages of its dynamos.

In this country the naval demand for slow speed dynamos will be comparatively small;

Dynamo	Revolutions.	Watts in External Circuit.	Watts per square inch Floor Space.
Manchester, No. 6	350	9000	4.9
Edison-Hopkinson, 10 in L	350	168 0	6.9
Manchester, No. 7	400	22500	6.0
Edison-Hopkinson, 15 in S	420	39600	9.1
Crompton, $\frac{40}{11 0}$J	460	45100	20.3
Edison-Hopkinson, 8 in L	525	15400	6.5
Manchester, No, 5	525	6500	4.6
Ganz	670	50400	20.9
Crompton, $\frac{60}{11 0}$J	675	66000	26.4
Edison, No. 20	800	50000	8.8
Brush, H[3]	850	66000	23.5
Westinghouse, No. 18	900	30000	5.8
Hochhausen, No. 8	1000	35200	15.0
Mather, 500 Lt	1050	35250	8.5
Weston, 6 W. I	1050	11500	4.4
Brush G[4]	1050	28300	17.7
Weston 7 W. I	1100	20125	5.4
Westinghouse, No. 12	1100	18000	4.7
Brush F[5]	1100	19000	15.3
Thomson-Houston, H. I	1150	25600	9.0
Edison, No. 12	1200	30 00	7.7
Hochhausen, No. 6	1200	17600	13.3
Thomson-Houston, E. I	1250	13200	8.2
Mather, 400 Light	1300	28100	7 3
Edison, No. 8	1400	20000	6.0
Thomson-Houston, C. I	1500	6000	5 9

As illustrating the advantages of direct connection in economy of floor space and also of weight when care is taken, I have a few statistics of ship installation:

	Plant.	Connection.	Total Weight.	Floor Space.	Weight per 16 c. lps.	Sq. in. of Floor Space per 16 c. lps.
U. S. Steamer Chicago.	2 Edison No. 8 (200 lights) 2 Armington & Sims	Belting.	16000		40	
U. S. Steamer Boston.	1 Brush Compound (150 lights) 1 Straight Line	Belting.	10400		70	
U. S. Steamer Atlanta.	1 Weston 7 W. I. (150 lights). 1 Armington & Sims.	Belting.	6500	105 sq ft	43	101
Steam Yacht Alva.	1 Siemens' Compound (160 lights) 1 Willans' Engine	Direct. 450 Revs.	6700	27	43	24
French Iron-clad Indomptable.	2 Plants each. 1 Multiplex Gramme (160 lights) 1 Vertical Compound Engine.	Direct. 350 Revs.	7040	29	44	26
Torpedo Station.	1 Brush No. 7 Special (100 lights) 1 Westinghouse	Direct. 700 Revs.	4000	17	40	25
Torpedo Station.	1 Weston No. 8 Special (220 lights) 1 Westinghouse Automatic	Direct. 390 Revs.	9300	75	42	41

The preceding show a general average of about forty pounds dead weight of dynamo and engine for each sixteen candle lamp, whether high or low speed dynamos are used. In the following special attention has been paid to the manufacture of light and compact apparatus:

but if it serves to introduce the type into the market, I am satisfied, from what has taken place in Europe, that the system of direct connection will create a field for itself, as soon as the apparatus can be procured without the heavy expense attendant on special work. It recommends itself in any installation where either weight or floor space is to be economized. I believe it can be successfully utilized in lighting railway trains, especially if, in the near future, railroad com-

	Plant.	Connection.	Total Weight.	Floor Space.	Weight per 16c.lps.	Sq. in. of Floor Space per 16c. lps.
	1-200 Light Brush Compound 1.8 in. Brotherhood	Direct.	5500		27½	
Steam Yacht Restless.	1 Arnold Dynamo (30 lights). 1 Vertical Engine	Friction.	600	6 sq. ft.	20	29
	1 Goolden-Trotter Dynamo (75 lights) 1 Tower Engine	Direct.	900	5¼	12	11
	1 Victoria Dynamo (60 lights). 1 Brotherhood	Direct. 765 Rvs.	800	$4\frac{5}{10}$	13	11
Italian Cruiser Dogali	1 Parson's Dynamo (150 lights) 1 Parson's Steam Turbine. (3 plants like above).	Direct. 9000 Rvs.	900	6¼	6	6

panies have to furnish steam for heating purposes. Plants could be furnished small steamers and yachts in which a common installation could not find room.

There are one or two other considerations governing ships' installations. The principal is the absolute necessity of high insulation. The Bureau of Navigation has, in its recent contracts, called for an insulative resistance of one thousand megohms per nautical mile, after twenty-four hours' immersion in salt water.

That covering is also required as a protective against mechanical injury. We are so exposed to short circuiting and corrosion from salt water that the high standard called for is most wise. All switches, junctions and safety boxes, and, in fact, all parts of the circuit should be thoroughly insulated. Difficulty has been experienced from salt water running along the wires into lamp sockets, short-circuiting the lamps. The insulation of the whole circuit is sometimes required to be at least one thousand ohms for each volt at the terminals of the dynamo.

LIEUTENANT MURDOCK: One or two things occurred to me while reading the paper. Things which are necessary in marine installations are measuring instruments, both ammeters and volt meters which are independent of both gravity and magnetism. We want some kind of an instrument like a dynamometer, perhaps, or something of the kind which would be independent of the earth's magnetism and would not be affected by the local magnetism of the ship. Another thing which is necessary is the independence of the needle from the effect of the rolling of the ship. This has been already met by Sir William Thomson in his marine galvanometer, and I think in some recent instruments which I have not yet seen. The simplest way apparently is to suspend the magnet or needle or coil by a suspension which passes through its center of gravity. If this is accurately done, of course the force of gravity has no moment to act upon, and the rolling of the ship does not affect the needle at all.

I was requested to present these facts to the consideration of the convention, and I have to express my thanks for the courtesy extended in affording me the opportunity to do so. (Applause.)

DR. MOSES: I listened with great pleasure to that very interesting paper, and as there are some points in it which are of very great interest to a large class of our nomadic population, I would like to ask some questions of Lieutenant Murdock in regard to some statistics which he has omitted. Would he kindly let us know whether he has gathered any information as to the relative methods of laying wires on board ships; that is, are grounds used? Is the hull of the ship used as one of the conductors, or is there a tendency to have the circuits entirely independent of the ship itself?

LIEUT. MURDOCK. In England, I know, they use what they call the ship return, or, as they prefer to put it, the one wire system, but I do not think anything of the kind has been used in this country, and I should think it highly objectionable. All the installation required to be put in is protected by the highest attainable insulation—a double circuit and every part insulated. The system of earth connections has been used for quite a long time in torpedo service. Much of the torpedo apparatus in the navy has until within the last few years been arranged to work with the earth, but premature explosions have taken place and that has been discarded. To-day, as far as I know, all plants are installed with two wires and high insulation.

MR. KINSMAN: I would like to ask the gentleman if he knows anything about the experience of the steamship Alaska. They were at one time giving the one wire system a test.

LIEUT. MURDOCK. No, sir. I know they are using the one wire system on Mr. Vanderbilt's yacht, the Alva.

MR. KINSMAN: I thought they were experimenting with it with the view of putting it on other steamships.

DR. MOSES: I was crossing in the steamer Bourgoyne, of the Compagnie Transatlantique, and we had made a very rapid passage and everything was very lovely, when about four hours from Harve people began to be disturbed because the previous ship, the Champagne, had been run on the rocks at about that distance from Harve. We were talking of the matter, and all of a sudden we saw a stir about the ship and found the captain and one or two officers disappear, and we all made a start to find out what was going on. We found about 20 feet of the moulding smoking heavily and the firemen were at work tearing it down. When we got there, we found there was the beginning of what might have been a serious fire; it was started by the defects that Lieut. Murdock spoke of in the insulation. It is the hardest thing in the world to keep an insulation on a sea line. All of you who have houses at the seashore will have noticed that where the verandas or piazzas are painted with metallic paints that there is a tendency to a decomposition by the chlorides of the sea air attacking the carbonates, decomposing them and making them soluble as chlorides of lead or zinc, and you have the bare wood towards the sea and the rest of it nicely painted. If you want to make a good paint for a sea house, use the worst paint you can get—that is, carbonate of baryta, which would not be decomposed. All these insulations are affected by the chlorides that come from the salt breeze. In this particular case I took occasion to inquire into the subject. The hull of the ship was used for the return wire, and when I inquired into it—although the crew and officers were very well disciplined and very reticent I found they were always on pins and needles for fear fires would break out. Further investigation led me to find out that there had been a previous accident of the same kind, and although it looked very pretty, it is a highly dangerous thing, and we ought, in some way or other, to protest against it, because these accidents, if they occurred in times of danger, when people would be compelled to take to the boats, and the decks would be yawning, would be accompanied by twenty or thirty feet of fire, combined with other horrors. We ought, therefore, to protest against such a thing, as by such a paper as that we do in the best way.

MR. MAILLOUX: I would like to ask Lieut. Murdoch a question relative to the number of hours during which the energy is to be employed on board ship—whether the time of use will be pretty well distributed over the 24 hours of each day, or whether there will be parts of the day when the source of energy will be at rest, not being used.

LIEUT. MURDOCK: I suppose that ordinarily the incandescent light burns all night from before sunset until after sunrise. In some of the vessels, as in the monitors, I imagine the incandescent circuit may be partially used all the time. (The remainder of the speaker's remarks were inaudible to the reporter.)

MR. KINSMAN: I would like to ask the gentleman another question, and that is as to the average light of the incandescent lamps on board ship as compared with that on *terra firma*.

LIEUT. MURDOCK: I think there we work with a large factor of safety. They generally run them low. I have only been on board one vessel installed with the electric light. I found that 16 candles gave sufficient light when burned at 13. When a vessel is going on a long cruise it is a great advantage to save the lamps. I think in almost every case on a man-of-war the lamps will be burned under power.

MR. KINSMAN: Do you think light would be as long under similar circumstances?

LIEUT. MURDOCK: I think so, yes. As far as the lighting is concerned; the only difference is in the vibration, and there may be some kind of carbon that would not be effective. If the carbon was elastic, and people would stand the vibrations, and especially if the lamps were put on a spring socket, I think the lights would be as long as a good installation ashore. The discharge of heavy guns in the case of the Atlanta broke not the carbons, but the lamps. The lamps were left in the sockets in some cases to test them and the glass itself was fractured. When the glass goes it is no use to try to protect the carbon.

A MEMBER: I should like to ask Lieut. Murdock whether he has ever tried meters which are protected by an iron shield, which renders them independent of any magnetic influence. There is no necessity for the meter to be put perfectly level upon any table on any particular spot where the measurements are taken. I should like also to point out in connection with this subject that in British men-of-war it is the tendency to use the double wire system, because by using the ship's side as a return there is a large liability for leakages, as pointed out by Dr Moses.

LIEUT. MURDOCK: I have not been able to use the spring meter on board ship. With a Card volt meter the needle would vibrate about 4 volts, and with the Perry ammeter it seemed to vibrate about the same number of amperes. I don't know of anything in the market to-day better (remainder inaudible.) I believe in the British navy they have been using a portable form of Siemens dynamometer, and some of them have been ordered here in order to test them.

DR. MOSES: I am sorry to trouble you again but there is some further information I would like to elicit. Signaling, I presume is a very important thing on war ships, and it is very necessary that you should be able to use both small and large lights. Now, is it your experience that a 100 or 110-volt circuit is adapted to the use of arc lights, or would it not be preferable to have a 50-volt circuit on board ship, so as to be able to use your arc lights directly in multiple arc?

LIEUT. MURDOCK: I have recommended in the paper 70 volts. Of course our experiments with these search lights have been going on a great many years, and the general tendency seems to be that at least a tenth of an ohm dead resistance has a very steadying effect on the light, no matter whether we use a hand lamp or an automatic lamp. A little dead resistance seems to give us better working. The search lights are used so seldom, and our general method of working is so economical, that we do not care for the energy we waste in these dead resistances. The search lights themselves are of French manufacture, though I think the Brush Company, of Cleveland, have made essentially the same apparatus. I must confess, perhaps, to a little disinclination to use an incandescent lamp at 50 volts. I would rather take a little higher potential, and work a lamp about four watts per candle, and try to get more light in a shorter time.

DR. MOSES: Have you ever visited the installation on board the United States Fish Commission steamer Albatross?

LIEUT MURDOCK: I am familiar with the details, but have never been on board the vessel. They use the old Edison B lamp. Of course, if we want to take a B lamp with 55 volts, we can do it better than with a 16-candle lamp of the same potential.

DR. MOSES: On a recent visit to Pittsburgh I saw everywhere an installation of 50-volt lamps. It appears that the Westinghouse Company, of Pittsburgh, have adopted that as a standard. Their reason for adopting it, as I am told, is on account of the economy of the lamp. They get greater watts per candle power. That, it seems to me, also permits of the use of arc lights directly in the circuit. Incandescent light people, as a rule, neglect the arc lamp, and arc light people neglect the incandescent light. It seems to me there should be an imitation of the harmony that prevails here, and they should unite in one system the advantages of all. Arc lights should be used with incandescent lights. And yesterday some one, I think Mr Smith, of Pittsburgh, suggested that an arc light can be used direct from converters. If Mr. Smith is present, he will confirm or deny it; but I presume it must have been on a 50-volt circuit.

MR. SMITH: It was Mr. Kinsman, of New York, who mentioned that. It was news to me.

MR. KINSMAN: Some seemed to question the ability to run on very high voltage. They asked me if it was possible, after the adjournment. I have run them equally well on 100 volt converters. Fifty-lights are, however, desirable.

MR. DECAMP: May I ask if there is any loss of current in running it on a hundred volt current?

MR. KINSMAN: They are obliged to lose some. I have not the data with me. We have reduced it very much from what it was a few months ago, and we hope to eliminate the whole of it, and I think we shall very soon. One of those lamps I spoke of I operated with less than a quarter of an ohm's resistance.

DR. MOSES: The discussion brings out such facts that have occurred to me that will answer some of the points that have been raised and some of the questions asked. I happen to have made the first experiments on board the Steamship Albatross that I spoke to Lieut. Murdock about, with the use of an arc light on incandescent light circuits. It was a 55 volt circuit. It was a lamp directly in the circuit and one that was operated by a portion of the current, and the lamp was invented to run on incandescent light circuits. While there it was found, after a great many experiments, that there was a normal length of arc. You may, of course, draft lamps for any voltage, but it is found by experience, taking carbon in its chemical composition and the tendency to an extinguishment of the arc, that a certain length of arc, perhaps from an eighth to a quarter of an inch, is best adapted to arc lighting. For that reason it is necessary to have about 45 volts between the terminals of the lamps, and if you are running a 55 volt circuit it gives you that limit of loss, which enables you to run out to any length right from the incandescent circuit on the ship. In this particular case there was about one-eighth of an ohm put in. It worked very satisfactorily. There was no winking of the lamps at all. The lamp itself was invented for a 55 volt circuit; but the difficulty of putting lamps in series on a multiple arc circuit is so great that it is not advisable. Therefore, the adoption of a 50 or 55 volt standard enables us to harmonize the arc and incandescent light in a most remarkable way. You can use your lamps directly from the circuit, and there are places of course, no one will deny, where an arc light is far superior to an incandescent light. It gives you five times as much light per pound of coal burned, and for large spaces it is very much more useful; so that it will be very desirable to adopt some general system where arc lighting and incandescent lighting could harmonize.

MR. KINSMAN: The lamp that I have reference to has been wound so that we have successfully burned two lamps—that is multiple series, on a 110 volt current. I have not the slightest doubt but that can be successfully done by the lamp in a very short time. That brings the thing down to a commercial basis and under all conditions.

DR. MOSES: But you must use two lights together. If you only have one you are compelled either to throw your superfluous power into resistance or into the light that is in use.

MR. KINSMAN: In general installation we are not going to put up two lights where they are not needed. Where there is only one light we keep it in that way.

MR. WRIGHT: Lieut. Murdoch speaks of one of the requisites for ship installation being the settlement of the voltage. I think that difficulty is entirely overcome with the alternating current system, as we can supply a converter to give you any voltage you please from our primary wires.

LIEUT. MURDOCK: I am very glad Mr. Wright suggested that. I think there is one objection to the alternating current on board ship, and that is for search lights. Our hand glass is rather a peculiar institution. The carbons are inclined at an angle and placed out of the line, the positive carbon being uppermost, so that the crater is turned toward the mirror.

MR. WRIGHT: I think there will be no very great difficulty about that.

LIEUT. MURDOCK: As most of the light is

given off from the end of the positive carbon in a continuous current, I fear that in an alternating current system we lose this advantage. As we are trying to get a system which will use either arc or incandescent lights from the same dynamo, the alternating current in this respect does not seem so good. I do not know that I fully comprehend Dr. Moses, but in the system I speak of we work our arc lamps parallel with each other just the same as we put in an incandescent lamp.

DR. MOSES: I would state more fully, then, that it is desirable, of course, to run an arc lamp exactly like an incandescent lamp, since the function of the arc is such that it is equivalent in a certain ratio to the constant resistance of the incandescent lamp if you only give it time to act. The arc is a constant for every voltage, so that if you use a multiple arc arrangement, and you have a 50 volt circuit, since the arc for a 50 volt lamp is best adapted for arc lighting, it is advisable to use the 50 volt circuit for that purpose, putting two lamps in series, or to throw in a considerable amount of resistance if you use a 70 volt circuit, as you suggested.

I would just say, there were some experiments carried on by Capt. Tanner and myself on the Albatross, for the purpose of using a search light. In fact, we used this arc light as a headlight going around Wilmington, and found in a storm that it worked very well, but an arc light can be used on an alternating current, and if you use it for a search or signal light the alternating current presents peculiar advantages. You have your reversals of current, and you can make your flashes and signals come in with your alternations of current. You could alternate the flashes very nicely in an alternating system.

MR. KINSMAN: I would like to ask Lieut. Murdock if he has any difficulty in the feed of the search lamp, and what the nature of the difficulty is.

LIEUT. MURDOCK: I am afraid if I go into that I shall have to describe the lamp.

THE CHAIRMAN: Gentlemen, we shall have to cut the discussion a little short, as there is one more paper to be read this morning. What disposition will you make of this paper of Lieut. Murdock's?

MR. PHELPS: I move that it be accepted, with the thanks of the association, and entered in the proceedings.

The motion was carried.

THE CHAIRMAN: I am very sorry to inform you that I hold in my hand the resignation of Mr. Morrison, president of the National Electric Light Association—something that I did not expect.

DR. MOSES: I move that it be indignantly refused.

The motion was numerously seconded.

THE CHAIRMAN: All those in favor of accepting this resignation say aye.

MR. DECAMP: That is not the question. Dr. Moses' resolution was seconded.

THE CHAIRMAN: All those in favor of refusing to accept the resignation of Mr. Morrison will please signify by saying aye.

The motion was carried unanimously.

THE CHAIRMAN: The next business before the meeting is the report of the Committee on By Laws—Mr. A. J. DeCamp.

MR. DECAMP: That will have to be made a special order for some future meeting. The committee is not prepared to report. They have formulated their report, but it is very radically changed from that report which was made yesterday, and we propose to get it printed and distributed among the members, that they may be prepared to discuss it when it comes up. I would, therefore, move, if it does not interfere with any of the other arrangements of the association, that it be made the first business in order to-morrow morning.

The motion was seconded

MR. STEUART: I would also suggest that it might be well to make some provision in view of the special order made for to-morrow morning by the motion yesterday. The discussion of Mr. Garratt's report has been made the special order for the first thing to-morrow morning. It might be well to give this precedence.

THE CHAIRMAN: The motion is that this matter be made the first thing in order. Are you ready for the question?

The motion was carried.

MR. CALKINS, on behalf of the Committee of Arrangements, made some announcements with reference to the excursion.

THE CHAIRMAN: I have also an invitation here from Mr. Meigs, of the Elevated Railway, East Cambridge. I have also an invitation from the New England Telephone and Telegraph Company to visit their works, and asking us to designate a time when any or all the members will make this visit.

The next paper is by Dr. Waldo, on instruments for bending tests of line wire.

DR. WALDO, of Yale University: If you will excuse me just one moment I should like to go into the lobby and get that little instrument.

While Dr. Waldo was absent from the room Mr. DeCamp spoke. He said: Mr. Chairman: While you are waiting I would like to lay before you a communication which is a matter of information. It is not information growing out of any official action of this association, but it is a matter with which you are all more or less familiar, and several questions have been asked me in reference to it. The secretary will please read it

The secretary read as follows:

"The committee of the association of electric light companies for mutual protection against exorbitant prices of carbon, after careful deliberation on the subject desire to announce that in view of the collapse of the late carbon combination and the unsettled condition of the market, it is not deemed advisable at present for the association to take further action towards establishing a manufactory for the concentration of a large number of contracts for carbon, believing fully that the individual companies will experience no difficulty in placing their orders at fair and satisfactory prices.

W. S. FREAR, Secretary."

The secretary read the resignation of Mr. Charles Cooper as treasurer of the association.

DR. MOSES: I would like to repeat the same resolution that was offered with regard to our president, were I not forbid from doing so by Mr. Cooper himself, whose great good sense suggests—and I should lay it before the convention in his words—that the treasurer should naturally be in the neighborhood of the president, because it frequently happens that the president is not aware of the deficiencies there may be in the treasury, and orders are frequently given for sums greater than the condition of the treasury would warrant. Therefore it is desirable that he should have at his elbow some one who can tell him the balances, and therefore I think it is eminently proper. Well, I will not anticipate a resolution that will appear later before the convention, and may close by offering our thanks to Mr. Cooper for the efficient way in which he has conducted the office.

THE CHAIRMAN: Gentlemen, you have the resignation of Mr. Cooper now before you. What action will you take?

MR. STEUART: I move that it be accepted with thanks. (Laughter.)

MR. STEUART: That may need some explanation. I have no intention whatever of thanking Mr. Cooper for resigning, but only for the very excellent service he has given in the past.

Mr. Steuart's motion was then carried.

DR. WALDO: Mr. President and members of the convention: In looking over some specimens of wire which were sent to the Baltimore and Ohio Telegraph Company, Mr. Maver and I were very much impressed with the uncertainty of the bending test of line wire. Very simple devices are oftentimes very advantageous in use, and I thought it might be of interest to tell the convention of a simple tool which will give more or less uniform results in the bending tests. The objection to taking a piece of wire in your hand and bending it, as is ordinarily done, is this—that a piece of wire bent at an angle here (illustrating) will break, not in proportion to its strength or its value as a wire, but in proportion to the diameter of the wire and its crystalline structure. A very hard drawn wire, for instance, will break with much less bend around a sharp angle than around an angle of its own diameter. I noticed that in all the tests described by the division of postal telegraphs in England, Mr. Preece is careful to insist that the wire be bent around its own diameter. Any of our hard drawn coppers will break after one, two or three bends. The little instrument which Mr. Maver and myself constructed is merely a pair of plyers which can have a pin of different sizes inserted at its center of motion, and will grasp the wire uniformly, and it is meant to be screwed to a board, so that the angle at which the wire finally breaks on the last turn is accurately shown. I think as the mechanical properties of wire come more and more into consideration and become more and more desirable, as they rapidly are becoming, that it is extremely important that we have a uniform system for this bending test, and I do not know of any better condition than that the wire shall be bent around its own diameter—a pin of its own size held by some such instrument as this, and that the number of degrees that it takes on its last turn shall be registered. For instance, we know that a wire will take three right angle bends and we will say fifty degrees more. You can make any simple arbitrary convenience as to the number of degrees of bending that a wire will stand, and as many of our wires will break at a single bend or bend and a half, it is very important that we keep the last number of degrees which the wire bends, in order to have any indication of the mechanical value of these high grades and hard drawn copper conductors. This little instrument is very crude; it is the first one that was made. Of course the next one will be simpler and better. (Applause.)

THE CHAIRMAN: Dr. Waldo, will you read a paper on silicon bronze wire?

DR. WALDO: It was merely some remarks. In a discussion with Mr. Preece, and also in correspondence with the Lazar-Wyler people in Paris, I became a good deal interested in this silicon-bronze question. I take it that we can look upon all conductors of electricity as merely transparent to electricity, so to speak, and that electricity will travel through them a good deal as light will travel through glass. [Applause.] In our dense ignorance as to the ultimate nature of electricity, of course, we can only surmise in regard to this point; but I take it that that is a good practical conception to bear in mind. Now, it has been found that very small quantities of alloys, or the earthy metals, introduced into a very good conductor, has very much the effect of the introduction of a small amount of iron, or any discoloring influence, into glass, upon the transmission of light; and that has been found particularly true of some of the earthy alloys—arsenic, for instance, and phosphorus and silicon. But there is also a peculiar physical change, which takes place when silicon or phosphorus is added to the bronzes. What that change is, I do not know; but in thinking the matter over, it has seemed to me that the addition of a small amount of silicon or phosphorus must enable the atoms of molten copper to effect a certain nearer relation to each other—that the centers of the atoms, so to speak, are allowed to come a little closer, and that the tensile strength is much increased by the addition of these small quantities of the earthy alloys. But whatever the cause may be, it is an experimental fact that the addition of small quantities of phosphorus and silicon, and perhaps some other alloys, has given us bronzes which have high tensile strength without any greatly lessened conductivity, and by common consent the most of these bronzes have been those bronzes which contained sulphur. Now I began a series of experiments on silicon and its application to these bronzes, to see whether we could get conductors which should have mechanical properties of a high order, and at the same time have the transparency to electricity which copper has. The first results of these experiments, after two years of work, are beginning to show themselves, and I have here a number of specimens, which I shall be very glad to give to any person interested, of some silicon bronze conductors in which a high tensile strength has been obtained by using a core of silica bronze, and a covering of copper. You are all aware, perhaps, that some of the French engineers have made stretchings of a mile between supports in some parts of Algiers of very hard-drawn pure silicon bronze wire. But the trouble with it is that the conductivity is no greater than the conductivity of steel, and in most of our purposes we want high conductivity; so I was led into a variation of the ordinary form of conductors, and returned to the idea of a cord-wire. It was not possible to push the construction of pure silicon bronze conductors up to a tensile strength of 120,000 pounds to the square inch, and that rivals the tensile strength of the best steel. But as a conductor for large currents that was comparatively useless, and I therefore was led into the experiment of pouring the wire. I think by common consent the disadvantages of the old style poured wire arose largely from the difference in electrical conditions between the core and its surroundings. If any moisture got between the steel core and the copper covering we had a perfect electric pile and a certain amount of disintegration would take place between the core and its surrounding. Now that difference of potential does not exist between the bronze core and the copper covering of a silicon bronze wire, because they are so nearly alike chemically and their electrical condition is almost identical; but there is another very great advantage. The fusing point of silicon—that being an alloy of copper—is slightly lower than the fusing point of copper itself, and it became possible to put in ingots of silicon bronze and to cast around these ingots pure copper. There would be a perfect joint of fusion, so that when the ingots were taken from the moulds there was an ingot of silicon bronze covered with copper, which would have a perfect mechanical homogeneity, and those little samples which have been passed around the room are specimens of wire drawn with a silicon bronze core with the ends polished, so that you can see there is a difference in constitution of the metal, but it is almost impossible to separate the silicon bronze core from its outside covering. This is a more or less complete solution of the problem of having electric light conductors of very considerably more tensile strength than anything which copper can give, and yet possessing almost the conductivity of copper. In the case of smaller wires the amount of success reached is equivalent to about the following figures: A wire $\frac{103}{1000}$ of an inch in diameter will break at about 650 pounds, and for torsion and bending it is much more satisfactory than the best hard-drawn coppers which we have been able to get. You have, too, variable quantities of conductivity and the tensile strength, and you can save either at the expense of the other; so that it becomes possible by using the silicon bronzes, to vary for particular conditions either of those qualities; and I think the experiments which we have made bid fair to be successful in producing permanently a conductor—not perhaps better than copper, because we purify our copper more and more. The present conductors of copper will undoubtedly be increased, but a conductor which is very good and which will possess mechanical properties which thus far have not been available.

One thing more as to the ultimate course of experimenting in this direction. The silicon bronzes made in Europe have been expensive because of the prohibitory prices put on by the owners of the only patents under which they could be made—the Lazar-Wyler patents; but owing to the genius of the Coles in the working of their smelting furnaces, by which silicon can be reduced from its quartz in a much less expensive way than any other that has yet been tried, and in consequence of the low price of silicon, these silicon bronzes will be made doubtless at a cost which will not at all be prohibitory

for their use on places where wires happen to be swung from supports, and tensile strength becomes of great value. (Applause.)

DR. MOSES: Mr. President, the very interesting remarks of Dr. Waldo have elicited from my neighbors here a comment which I would like to bring to the attention of the convention. He suggests that perhaps the hard-drawn core being more slowly acted upon by its own weight in stretching, would perhaps break after the outer covering had yielded. In experiments on the tensile strength, they are conducted so rapidly that there is no opportunity that I see for fatigue of metals becoming a factor. It recalls to my mind a remark that was made to me by one of the engineers of the Brooklyn Bridge. He said that he was anxious in the course of a good many years to find out what the effect would be of the introduction of quite a number of what are called hard wires into the cables of the Brooklyn Suspension Bridge. It appeared that some dishonest contractor had given, strange to say, a better wire than he was called upon to give—that is, a hard wire instead of a soft one; but it had come in the course of his manufacture, and he had thrown it into the lot of wire forwarded, and in the tensile strength experiments made it was found to be unsuitable to the bridge, but still he found a means of getting it in. I believe the man is suffering to-day for it in one of the penitentiaries. The conditions were similar to those spoken of by Dr. Waldo, though not exactly the same. The hard wires are supposed to be in that condition that, yielding less than the soft wires, the ultimate strains will be drawn upon by the fatigue of the metal in the course of years, so that those wires are, practically speaking, getting the whole strain upon them. I mention that so that in conducting further experiments, if you can introduce time into the experiments so as to see the effect of fatigue on the copper covering, it will be a very interesting thing.

DR. WALDO: I think the whole question of the mechanical testings of wire is one of extreme importance. I have been very much struck in testing long series of wires with the disturbance caused by this very fatigue of the metal of which Dr. Moses speaks. In using a testing machine for testings strengths, it is of the utmost importance that the strain be applied very gradually, because you could all get different results in a machine where the strain is applied gradually at an interval of several minutes, we will say for each wire, and where the strain is applied rapidly. I, for one, would like to see a committee or some representative body which should take under consideration the unifying of the mecanical tests for wire for electrical purposes. I think both the bending and the torsion and the breaking tests are all now made very much as a particular whim of the company or person using the wire prescribes, and if we had a uniform method of making these tests we should have data for preparing conductors mechanically in a way which is not now possible. I do not know but that I am ready to make a suggestion that a committee be appointed having for its province the consideration, for report at some future meeting of the convention, of the best means of establishing a uniform system for the mechanical testing of wire for electrical purposes.

DR. MOSES: I think, Mr. President, that is a very excellent suggestion, and I hope that the president, in appointing that committee, will consider the extent of the investigations of Dr. Waldo by referring the matter to him as one of the members of the committee. There is, I think, a committee appointed for the purpose of considering insulations and wires in general. But this might be made a special subject of investigation, and if it is the pleasure of the convention to appoint such a committee, I hope Dr. Waldo will take charge of it.

THE CHAIRMAN: Gentlemen, I should be very much in favor of appointing such a committee as that. But I was rather in hopes that the appointment would come from Mr. Morrison, as he is, perhaps, more familiar with the transactions of this association than I am. But as he is not here I will appoint Dr. Waldo on that committee, and Dr. Moses. Is there another committee already in existence that this could be attached to?

DR. MOSES: It strikes me that the committee of which Prof. Thomson, of Philadelphia, was in charge had a similar matter in hand?

THE CHAIRMAN: I will add this committee to that committee.

THE SECRETARY: That committee resigned and another committee was to be appointed. That committee was on the proper insulation of wire and the proper installation and construction of plants.

THE CHAIRMAN: We will leave that matter open then until the President appoints the other committee, and join this committee with that.

MR. MAILLOUX: In regard to the conductivity of copper, of course it is important to use the specific resistance of the copper, and I would like to ask Dr. Waldo a question particularly directed for finding out whether electrolitically-produced copper has ever been used in making wires. I have had considerable experience in making copper by electrodeposition, and I found it is possible in that way to make a copper which is not only very pure—sometimes 999 fine—but it is also a very ductile substance, and it can be bent a large number of times without showing an absolute rupture, and it seems to draw out in bending, so that the broken ends look very much like an electric light carbon for instance, and it occurred to me that perhaps some attention should be given by wire makers to the use of that kind of copper.

MR. WALDO: I confined our experiments at first to copper which was electrically deposited on the cores, and we obtained some remarkably fine specimens of wire in that way; but the cost of the process was prohibitory, and the copper which I have used frequently is merely the highest grade of Lake Superior copper.

MR. MAILLOUX: Referring to electrolytically deposited copper, I did not mean that it was deposited on a core by electricity, but I referred rather to copper which has been produced in the form of slabs by means of electrical deposition. There is now a firm here in New York that has produced, I understand, some 500 tons of plates of copper per month by means of electrolysis, and I meant particularly copper which can be used in ingots just like any other form, except that it is very pure and exceedingly ductile.

DR. WALDO: There is great danger in the welding of copper. One of the most insidious difficulties in the manufacture of high grade conductors is the introduction of a sub-oxide and a protoxide of copper as an impurity, and I am very much afraid of any process which involves the constant melting or re-melting, and I should be afraid that electrolytically deposited copper would lose all it would gain by being electrolytically deposited in any ordinary process of melting. The protection of that copper during melting has been one of the most serious difficulties that we have had to face.

DR. MOSES: In the refining of copper the solution of protoxide of copper in the copper itself is one of the difficulties in the way of getting a pure copper by ordinary smelting processes, because it seems to disseminate itself so thoroughly in the mass of the copper. Now in electrolytically deposited copper that is not the case, but there are other objections that Mr. Stanley speaks of, and I wish he would bring them before the convention.

MR. STANLEY: I should like to ask the gentleman if he has ever thought of the self-inducting value of the wire—a compound wire having a bronze core and copper sheath. It seemed to me there might be a secondary action set up in that core that might be very prejudicial to the use of it in alternating currents.

The convention then adjourned until the following day at 10 A. M.

THURSDAY MORNING SESSION.

The report of the Committee on Revision of the Constitution was the first subject taken up after the opening of the session of Thursday forenoon.

After some discussion the constitution as reported by the committee was adopted with some few modifications. The following is the new constitution:

The name of this association shall be "The National Electric Light Association."

Members of this association shall be companies, firms, or persons, operating electric light and power stations for public or commercial purposes, manufacturers of electrical supplies and apparatus. Electricians, electrical engineers, and persons, firms or companies whose professions or business is directly collateral thereto, may become members upon the recommendation of the executive committee and approved of by the association.

Each member in a vote by ballot shall be entitled to one vote.

A ballot may be demanded by one-fourth of members present.

Persons may become honorary members, without the right to vote by ballot, of the association.

The officers of this association shall be a president, two vice-presidents, treasurer and secretary, and an executive committee of six members, the president, vice presidents, treasurer and secretary being members *ex-officio*.

The president and vice-presidents shall be elected by ballot to serve from the close of the annual meeting at which they are elected, until the close of the next annual meeting.

The treasurer and secretary, who may be one and the same person, shall be nominated by the president, subject to the approval of the executive committee. The executive committee shall be chosen by ballot at each meeting, either annual, semi-annual or special, to hold office from the close of the meeting at which they are elected until the end of the meeting at which their successors are chosen.

The duties of the several officers shall be those usually pertaining to their respective offices.

The treasurer, secretary and executive committee shall make a written report at each meeting, to be spread upon the records of the association.

The executive committee shall be the governing body of the association, three of which shall constitute a quorum. They shall meet from time to time and shall report upon application for membership, gather and prepare information upon topics of interest, and arrange for their discussion, at the several meetings of the association.

The annual meeting of the association shall be held in February, and the semi-annual in August of each year at such place as the association shall determine, and such date as may be determined by the executive committee.

The membership fee of each member shall be $10—which shall accompany the application.

The annual dues shall be $10—payable in advance, and shall cover the calendar year.

All amendments to the constitution shall be presented in writing and referred to a committee to be appointed by the chair before being acted upon by the association; a two-thirds vote of those present shall be necessary to their adoption.

A ballot on such amendment may be called for upon the request of five members of the association.

As reported by the committee, the one section contained the following clause:

"The same person shall not be eligible to the office of President and Vice-President for two successive terms."

The striking out of this clause, on motion of Dr. Moses, was the only material change made in the constitution as proposed by the committee.

MR. C. B. DE LA VERGNE, of Boston, proposed a series of amendments making ineligible to appointment on committees, persons interested in the subject-matter of such committees' investigations, through a pecuniary interest in an article which the committee's report would affect, and also providing that no person should be appointed on a committee to report on an article or commodity, who had not some familiarity or practical experience in the use of the article or commodity which was to be the subject of the committee's report.

The amendment, after some discussion, was rejected, the reasons against it appearing to be that it was incapable of being practically carried out, and that the best committee work would be done, as it had been done in the past, by persons directly interested in the subject-matter of the particular committee's investigations, and that any attempt on the part of one member of a committee to intrude too much of his own personal interests in the work would be promptly checked by other members.

THE PRESIDENT: The next business in order is the report on wire gauge by Mr. Garratt.

MR. GARRATT: I made all the report I had to make at the first session of this convention. I did not know that I was to be called upon for anything further.

THE PRESIDENT: The convention laid the matter over until to-day, and the question was upon the adoption of the report made by the Committee on Wire Gauge.

MR. PHELPS: I have a resolution to present for consideration in respect to the report of the committee, in consonance with the ideas I expressed here the other day on the subject:

RESOLVED, That the report of the Committee on Wire Gauge be received and the committee discharged with the hearty thanks of the association for the valuable work accomplished by them and presented in their table of the mathematical properties of the metric gauge; and it is further

RESOLVED, That in view of the large number of gauges already in existence and the confusion arising in their use, it would, in the judgment of the National Electric Light Association, be inexpedient to promulgate an additional gauge. The association earnestly recommends to its members and all others using copper wire the practice of designating sizes by definite diameters, such practice having already come into extensive use, as a feasible escape from the confusion of many gauges. The association further recommends the use of the meter and its fractions in designating diameters, and in furtherance of that end, publishes the tables presented by its wire gauge committee August 9.

MR. A. F. MASON: When I made the motion to make this the order of the day it was in view of a resolution like the following, which I will beg leave to submit as a substitute for the other:

RESOLVED, That the report of the wire gauge committee be accepted; it being understood that by accepting it, we as an association commit ourselves to the following:

1. That in reports, communications, etc., we will designate wires by their diameters expressed in fractions of the meter.

2. That in our personal conversation and business we will designate wires in the same way, in so far as we find possible.

3. That this association offer to wire manufacturers such aid in the way of information as shall enable them intelligently to list their wires on the metric system.

Now, Mr. President, my point is this: If a man wants a gauge we have a gauge there in the table which has been presented to us. I beg leave to differ a little from the chairman of the committee on that point. The left hand column of figures upon the table which is before the convention contains arbitrary numbers, although they are based upon the second column—the tenth of a millimeter—but we have there a gauge and those numbers will undoubtedly, if such resolutions be passed, come into use by us. We can telegraph for wires under those numbers. I am very confident that the majority of the association feel that while we do not wish to go any further than is necessary in this matter, we want to do something that will commend itself to the users of wire and the makers of wire throughout the country. It seems to me that we are only following in the line of action taken by our government and taking a very modest step if we shall adopt the resolutions just read.

MR. GARRATT: I understand you, Mr. Mason, that that would not, of necessity, oblige us to do anything, only in so far as we found it convenient in our business.

MR. MASON: I understood, Mr. President, that a letter was read six months ago in our session from Messrs. Brown & Sharpe, in which they stated that they regarded the proposed metric gauge as very superior to their own, and if this convention would in some way adopt it or express its approval of it they would be very glad to adopt it for use in the measurement of their wires. That was a very strong testimonial to the value of this proposed system, and I would like some action taken which would lead them to do that which they proposed to the association that they would do. Other wire manufacturers will probably follow in the same line,

and, as a dealer in wires, I feel that we shall all be greatly convenienced. I received an order a short time ago for a number of miles of wire from the far West. The order simply read so much No. 8, so much No. 10 and so much No. 12 I sent them the Brown & Sharp gauge. They were to a certain extent useless out there. The gentlemen ordering used the Birmingham gauge. If it is understood that this association has, in a general sort of way, even adopted this metric system we shall have our orders and know what they mean.

MR GARRATT: I would vote strenuously against any adoption of any system of wire measuring which should, in a cast-iron way, c mmit us to it. I would not vote for the adoption of any system of measuring wire which would not leave each individual completely at liberty to do whatever he wished to do. If a man cannot find it more to his advantage to use this system while measuring than any other, we never can oblige him to do so, and I would personally decline to commit myself to it. My idea in regard to that would be this: Take such action as would leave us at liberty with the commendation and encouragement of the association to use a better system of measuring than we heretofore have had; the best I know of being the application to the wire of its simplest principle, namely, its diameter.

MR. MAILLOUX: I perhaps permitted myself to say too much in the previous discussion, and I may have been construed to mean that I disapproved of the work done by your committee. I think it is doing justice to myself and to the committee to say that I am heartily in sympathy with the work. I believe I took especial care to express my appreciation of the precision and care with which the work has been done. I agree perfectly with the sentiments just expressed by Mr. Garratt. I regard the valuable work done by them as a priceless contribution to the fund of knowledge which we have regarding the methods by which we measure the various properties of wire. At the same time I am aware, as you all are aware, that in this country the inch is used very extensively. Since the discussion on Tuesday I have taken the opportunity to speak of the matter with several gentlemen, makers of electrical machinery, who are using wire in very large quantities, and they have told me that so far as they were concerned they could only make use of this gauge to a very limited extent—that it would not apply to their purposes—that they would adhere to the method of determining sizes by thousandths of an inch, because as they use the foot as the unit of length it would be very inconvenient to determine the area of sections of conductors in one system of measurement and the length of it in another system of measurement; so that in making computation as to the space occupied by wire or as to the weight of wire, they would find themselves in a worse predicament than they were before. I also noticed that in wires of certain applications the thousandth of an inch is more convenient than the other. Now, I believe that while the system proposed by the committe is very valuble, and it has undoubtedly a great range of application, I do not think that we ought to force people to accept it, because if one system is more applicable than another the person who finds it of greatest convenience to use that system ought to have the privilege of using it. Consequently, I oppose the motion.

MR. EUSTIS: I would like to speak in regard to that computation of weight which the gentleman was speaking of—changing from millimeters into feet; that is, measuring the diameter in millimeters, and yet computing the weight for a given length in feet I think if he had studied the table as much as I have, perhaps, he would have found it just as easy to make that calculation or for anybody to make that calculation from the number which is given as the logarithm of the sectional area, and then by simply multiplying that one number by a constant, you can get the pounds per thousand feet, which is given here. It is immaterial in any computation of this sort, whether you start with an inch or with a millimeter in making the final determination. The constant holds true: because your length, your weight per thousand feet is proportional to the sectional area multiplied by some given constant. Whether you take the sectional area in inches, or whether you base it on millimeters, it is immaterial. I have here the constant for the calculation of pounds per thousand feet. I will just put that on the board in case anybody would like to have it (illustrating.) That is the constant which is to be subtracted from the logarithm of the area given in square millimeters.

MR. MAILLOUX: It has happened with me several times that I had to make calculations that very way. I am perfectly aware that it can be done, but I was merely referring to the confusion that is likely to arise where you are accustomed to calculate volume by one method. You are quite likely, especially where there are numerous calculations to be made, to forget the constant. I have been obliged recently to make a great deal of use of the metric system in calculation, because I had to design apparatus with reference to plans sent over to me from abroad, which were made in the metric system In a case like that I find it very convenient indeed; but where it is necessary to pass from one to another I have found in several instances that you are likely to be confused by forgetting the constant.

MR. EUSTIS: As the gentleman has spoken about mislaying his constant, I would simply ask him how he obtained a constant for the determination of the weight per thousand feet where the diameter is given in inches. If he has to determine that every time separately, why is it not as easy to determine that in the metric system as in feet and inches.

MR. MAILLOUX: I mean the constant of converting the length of the wire into meters or fractions of it—(inaudible).

MR. GARRATT: I simply want to make this request. I have gone to the blackboard in explaining this gauge and my associates have done likewise. I wish gentlemen would not make dogmatic statements Let them step to the blackboard and demonstrate their statements there. It is not fair to rise against mathematical statements with dogmatical remarks. I three times called the gentleman to the blackboard to demonstrate against conclusions which I had stated. He opposed three statements I had made, and three times I asked him to go to the blackboard and show wherein I was wrong, and three times he declined to go there.

MR. STEUART: I have only one word to say. This opposition to the motion as it now lies before the house reminds me very much of a bugaboo—it is an imaginary evil that may come and may never come. The question of whether this gauge would be useful is altogether a question of the survival of the fittest. The question which presents itself practically is whether this thing will prove to be so much better that every one will adopt it in preference to inches, and I think that is the only question which is to be determined, and that can only be determined by practical tests in actual use, and I think that the opposition to the passage of this motion, which is merely a suggestion on the part of this association, is altogether out of place.

MR. GARRATT: I call for the question on Mr. Mason's motion.

THE PRESIDENT: The question now is on the substitute of Mr. Mason for the motion made by Mr. Phelps.

MR. PHELPS: I have only one word to say, sir. Having prepared the first resolution, I naturally have a little preference for that. There is not very much difference between them. What I have undertaken to do there was to emphasize particularly the desirability of sticking to the principle of designating actual diameters, and rather avoid the notion of promulgating a new gauge. The other resolution does not differ very much from it, but there is a slight difference between them, which, perhaps, might be considered.

Mr. Mason's resolution was again read by the secretary.

MR. S. S. WHEELER: That resolution is so strongly worded in regard to this association committing itself to certain things that I think we want to be very sure before we do commit ourselves, that the gauge proposed is a good one. All the gauges that have grown up from the needs of wire-makers have had the notches made so that the larger sizes differed by larger spaces than the smaller sizes That is very well shown by the charts prepared by the Committee on Wire Gauges where the numbers are placed so as to correspond with the old gauges and the first number equals No. 38 of the ordinary gauge and the second number equals No. 32. Therefore the gauges we have been using for the fine wire sizes have six numbers in between the first two of the new proposed gauge, and at about the bottom of the chart, at about No. 00 of the old gauges there are nine numbers of the new gauge which correspond to the one No. 00 of the old, which shows that in the fine numbers the new gauge does not have fine enough differences and at the bottom the new gauge has too fine spaces. That is to say, take a No. 38 wire for instance, which differs from No. 37 by half a thousandth of an inch and in the new gauge the difference is six times that, which is not fine enough for practical work. We are sure to need some number between No. 1 and No. 2 of the new gauge, and at the bottom we have one number of the old gauge which covers nine numbers of the new. I think, therefore, that the best thing, in view of the fact that we have now 25 or 30 gauges in use, is to pick out some one which is the best that we can find, and not create a new gauge.

MR. GARRATT: I would say in that connection simply that before two conventions I have debated and explained at length the objection raised by the gentleman. He will find it in the ELECTRICAL REVIEW and in a number of the other papers. I have suggested no gauge. That is simply a table by which from the tenth or the hundredth of a millimeter you can determine the property of any wire you wish. Again, the gentleman says, let us pick out a gauge from the existing gauges. Of the present existing gauges there are 14 Birmingham gauges in use to my knowledge and there are 30 or 40 Brown & Sharp gauges used in America. The question of their being in the small numbers too great variation has been replied to and replied to until I am sick and tired of it. Any mathematician who knows the rule of three can construct from any one of these small numbers the properties, electrical and physical, which he requires. In ordering wire he can order by the hundredth of a millimeter and he can determine that by the micrometer. The statement that those numbers do not correspond to the Brown & Sharp ratio is entirely impertinent to the question. I repeat that I have advanced no gauge.

THE PRESIDENT: This discussion has gone along far enough, and the hour for adjourning the morning session has arrived. Before adjourning, however, it is necessary to dispose of this business. The question now is on the adoption of Mr. Mason's substitute for Mr. Phelps' resolution.

Mr. Mason's substitute was lost.

THE PRESIDENT: The question now occurs on Mr. Phelps' resolution.

Mr Phelps' resolution was carried.

MR. DUNCAN: I desire to enter a motion that the semi-annual meeting adjourn this afternoon at 5 P. M. I make that motion in order that the members may regulate their time for the clambake and such other entertainments as they may want to take in, as also to expedite the business of the convention.

The motion was carried.

THE PRESIDENT: The first paper that will come up at the afternoon session will be that of Mr. Mailloux on the storage batteries, followed by Prof. Reckenzaun on electricity as a motive power, and a paper by Mr. Duncan on motors; and that is all that is on the programme at the present time, except to decide the place for the next meeting.

MR. WHEELER: I want to say that Mr. Garratt is dead right about the gauge question. I was trying to answer the second resolution; that was all.

MR. DECAMP: I move that the treasurer be directed to draw upon the funds of the association for $50 expenses of the attendance of the secretary at this convention.

THE PRESIDENT: It is the usual appropriation for the secretary.

The motion was carried.

MR. DECAMP: I have in my hand a bill for $60 for printing this paper. I move that the bill be paid.

The motion was carried.

On motion of Mr. Steuart the convention adjourned until 2 P. M.

THURSDAY AFTERNOON SESSION.

The convention was called to order at 2.30 P. M.

MR. LEGGETT: There is a matter which should be of very great importance to many of us—probably to all of us—the undergrounding of wires, which has not been touched upon in the convention. I would like, if it could be understood, that after the reading of the last paper, we might take that subject up for consideration and find out what we can rely on.

THE PRESIDENT: The suggestion is a very sensible one. You have all got to come to it in the end, as I told you two years ago.

MR. LEGGETT: I make a motion to that effect.

The motion was carried.

MR. MAILLOUX then read his paper on storage batteries.

THE PRESENT STATUS OF THE STORAGE BATTERY.

BY C. O. MAILLOUX.

In one of his masterly newspaper interviews a well known American electrician once said of the storage battery that it was chiefly remarkable for its power of stimulating the propensity for lying which is inherent in some natures. This sweeping assertion naturally makes me realize very fully the possible risk of compromising my reputation, which I run, in undertaking to make a few observations relative to the storage battery.

Under the circumstances an apology might seem to you to be a suitable preface, but I trust that a simple explanation will suffice to dispel all doubts on your part as to my good faith in the premises. This explanation rests upon the fact that the storage battery, like the dynamo, the arc lamp, the incandescent lamp, and many another thing, has grown and progressed. Only a year ago I would have hesitated, perhaps refused, to say anything before you in favor of the storage battery. My reason would not have been a lack of confidence, but rather a feeling that the era of the storage battery was not yet at hand. I felt that this youthful offspring of the great and powerful family of electrical applications promised to play as important an industrial role as any of its colleagues, but I also knew that it had already made one debut some years ago and failed to draw, because it was too young. I would have been sorry to see its chances of success forever spoiled by a second premature attempt. The child seems, however, to have now had sufficient time to mature and perfect its training, and after an interval of some five years it has reappeared upon the scene, this time with a fair and encouraging success. Within a few months there has been in America a great revival of interest in the storage battery, as you are aware. Many of us practical men, who were once disposed to be skeptical, begin to regain confidence. Certainly the applications which have been made of the storage battery in this brief period prove beyond dispute that this time the storage battery is coming to stay. In some cases it found a new and profitable field waiting for it, as for instance in railroad car lighting. In many other cases it opened an entirely new range of possibilities by its playing a secondary role. In a word it has a wide sphere of usefulness to cover, through many devious paths, some of which it alone can tread over, and many of which it will compass with the help of other applications of electricity. It does not presume to fill all these parts at once. In the case of some of them it may prove wise to permit the process

of evolution to go on for some time to come, before they are considered.

It is not necessary, however, for the storage battery to wait until it can accomplish everything before accomplishing something. There are many applications where it is now entirely competent to give satisfactory results; and while doing what it is at present capable of, it can learn what it does not know. The dynamo was not at first what it is now, nor was the lamp, nor, indeed, the details of lighting systems. Electric lighting was limited at first to isolated installations. The range of adaptability, compared with what it now is, was limited greatly. It was necessary to confine the applications of the light to isolated cases of fitness, since the apparatus was too limited in every respect to admit of doing more. But while we were doing what lighting could be done with these facilities—and making money, too, even then—we were learning to do more. Invention, and the yet greater force, evolution, were hard at work to give us better ideas and more practical devices. In time came the central station, such as it was—and I might emphasize the such. Many are here present, doubtless, who were operating these pioneer arc light stations, with long rows of dumnoy lamps, to be shifted in or out of circuit, for the purpose of balancing the work in the circuit itself. Then came the current regulator, and, following in its wake, a succession of devices and improvements of methods of systems. The evolution of the incandescent light is also of equal interest, and from the useless platinum wire lamp to the very useful alternating system of to-day, the steps are so numerous and strange that the mind finds itself in a regular museum, in attempting to retrace them. I need not tell you that the evolution of the electric light is not complete.

The very existence of our organization proves that, since our object is to promote and further the process of development. Each year we have found electric lighting advancing a few steps. Ten years from to-day we may have made so many of these steps that our present systems may seem obsolete. Yet these very systems in their time were good enough to earn dividends with. This is precisely the case of the storage battery. Its application can even now play a brilliant part in electric lighting; but it can be very useful, even if entrusted with a more modest part. In a word, it has arrived at that age and condition of development which fit it to enter the active service of civilization, and begin the race for promotion. If I may judge by the very favorable attention which the storage battery has received from the public, and particularly from those who are dispensing electricity to the public, I think I can venture, like our very genial friend and learned colleague, Dr. O. A. Moses, to prophesy that the storage battery is going to be the next great step of progress It has already taken its place in line, and I believe it will speak for itself inside of a year.

With regard to the storage battery itself, it may be said that in following its development since the days of Plante, one meets with an already large and interesting collection of ideas and devices. It is outside of the scope of the present paper to enter into the study of the steps by which the art has arrived at the present stage. The number of patents relating to storage batteries in this country and in Europe is already quite large, nevertheless the number of good storage batteries is exceedingly small. In this respect history repeats itself. The large and constantly increasing number of patents on dynamos, lamps, regulators, converters and what not, when contrasted with the small number of those inventions which are really useful, suggests that a large proportion of inventors must have been engaged too deeply in taking out patents, and pay altogether too little attention to the work of reducing their inventions to practice. Passing by the history of the seeondary battery and the theories of its action, which properly have no place in a paper like this, it might be of interest to dwell briefly on the objections urged against he storage battery. The two chief objections are limited life or durability, and low economy. I shall frankly admit at the start that in many cases these objections are sufficiently valid to throw the storage battery out of competition. The final commercial test of the storage battery, however, is the prospect of gain which it offers, under the circumstances of any given case. Viewed in this light, the above objections to the storage battery lose some of their force. I can cite as an example the case of a Philadelphia hotel which it proposed to light by electricity. A practical electric light man who has been engaged in the business of establishing and operating central station plants ever since the beginning of electric lighting, went over the case very carefully and came to the conclusion that the storage battery would be preferable. So well satisfied is he of the fitness of the storage battery that he submitted detailed propositions for furnishing light. The present cost of lighting the hotel by gas is $7,500 per annum. For the sum of $6.500 per annum, this practical man is willing to assume the responsibility of furnishing light for a term of years. Being a careful and shrewd business man he has made a wide allowance in his calculation. He does not count upon the two years guaranteed life of the battery plates, but assumes a necessity for their entire renewal in one year. He calculates, nevertheless, to make 15 per cent. on his investment, and I may say that he seldom makes mistakes in his ventures. In this case, the fact that light must be on "tap" for every moment of the 24 hours, becomes an important consideration, and the evident advantages of the storage battery outweigh the questions of durability and economy. Now, taking up the question of durability by itself, I may say that it is greatly dependent, not only upon the kind of battery, but even upon the use to which it is put.

Then perhaps he may neglect to put in more than the quantity necessary for a normal capacity. The result is that the battery is not fully charged, and to furnish the usual capacity it must be discharged by drawing upon its residual charge. He soon finds his battery giving symptoms of disease, and in a short time both the positive and negative plates will require doctoring, instead of one kind only.

It must be said, however, that improper care is not solely responsible for all the troubles that affect the life of the storage battery. Some difficulties, like the scaling off of the active matter, the buckling and stretching of plates, are largely inherent in the battery. They are natural consequences of the manner or method of making the battery. So it may be said that here the storage battery has a personal equation depending on the make, the care, skill and knowledge of the maker. This amounts to saying that some kinds of storage battery are more troublesome to keep in order than others.

The life of the storage battery plate must not be regarded as doomed to remain compassed within the term of a couple or three years. The limit is gradually being extended, and it may be said that each succeeding batch of the product of a factory is slightly better than the preceding. The same may be said of the cost, which, of course, is an important consideration, in view of the necessity for repairs or perhaps removals at certain intervals. The cost of manufacture has been reduced 30 per cent. inside of one year, and it is even expected that it will be brought down to 50 per cent. before the year is up. The prices have not been reduced because the demand is great, even as it is. This of itself shows that the storage battery has already a good field of usefulness where it can command to a great extent its own price.

The weight of the battery is another of the objections to be met, particularly for street cars, etc. This objection is one which is of particular rather than of general application. It depends on the battery. We know, however, practically, that with 27 pounds of active matter, it is possible to provide a supply of energy for six lamp hours, or over 10 watt less per pound of matter. This result will no doubt be improved upon greatly.

Last, but not least, among the objections used against the storage battery is that of reduced economy. My esteemed friend and colleague, Mr. Anthony Reckenzaun, whom you will have the honor of hearing after me, will give you very clear and precise information on this question of economy, more practically as regards the use of storage batteries for power. I will leave this portion of the subject to him because I know he is a most competent authority. I will permit myself also to commend his very intelligent work in Europe during the last five years, in the application of accumulators to electrical traction and propulsion.

The question of economy considered in relation to the storage battery does not present such difficulties as might at first be supposed. Considered as an apparatus for transforming energy for electric lighting by incandescence, the storage battery has an efficiency so much below that of the dynamo, or the transformer, that it cannot hope to enter into direct competition with these in many cases. Of the electrical energy produced by the charging dynamo, probably not more than from 65 to 70 per cent. finds its way into the lamps. With direct lighting, as we know, we may obtain as much as 90 per cent. But just here there is a question of great interest and importance which arises, namely, the proportion of energy appearing in the lamp as light. In an incandescent lamp probably not five per cent. of the energy expended is utilized as light. This five per cent. of rays represents the proportion of heat rays which are visible. The other rays are invisible. Now it is also well known that this very proportion of the useful light-giving heat increases with the absolute temperature of the filament. This means that the higher we raise the incandescence of the filament, the more light it gives for a given amount of electrical energy. But when the filament is brought to an excessive temperature its life is not so great. Just here I will note the fact stated by authorities, that alternating currents have been found to increase the life of the filament as compared with continuous curren'. Now I can supplement this with the statement that the storage battery current gives yet much longer life to the lamp. It permits the raising of the filament to a higher degree of temperature, and, consequently, it leads to a gain in the energy required.

We have found in practice that we can obtain the same average life of 600 hours with a lamp of $2\frac{1}{2}$ watts per candle power, while direct currents would require lamps of $3\frac{1}{2}$ to 4 watts per c.p. In our early work, realizing the great disadvantage at which we are placed, we resorted to the use of lamps of higher economy, so called. The makers of these lamps refused absolutely to give any kind of life guarantee. They were themselves yet more surprised than we to learn of the remarkably long endurance of these lamps, even on board cars, where the filament is subjected to the wearing effect of mechanical vibration.

Of course I cannot pretend to say what is the cause of this increased life of lamps with the storage battery current. It is probably related in some manner to the fact that the current of a storage battery is continuous in the strict sense of the term, while the current of dynamos and transformers are wavy in character.

It would seem, therefore, that so far as electric lighting by incandescence is concerned, while the storage battery is opened to the objection of wasting at the spigot, it can claim some saving at the bung-hole, which quite nearly equalizes the difference between the results obtained by the direct and the storage method. Taking our 65 per cent. of energy, or in round numbers 485 watts, we can obtain twelve lights per electrical horse power of 746 watts produced in the dynamo, using lamps of 51 watts, which is the most economical yet heard of with a continuous current, we have the following results: Out of 746 watts, taking 90 per cent. as available at the lamps, which is a liberal proportion, we have 671 watts or less than 12 lamps, or less than 12 lamps of 51 watts. If we consider the fact that in practice, lamps of 60 to 70 watts per 16 candle power are the rule, the difference would be yet greater in favor of the storage battery. Taking another view of the question, we can calculate what is the lowest per cent. of efficiency permissible in the storage battery.

Taking 11 lamps as the result of the direct application from the dynamo, we find that the storage battery must, at 40 watts per lamp, supply 440 watt hours out of each 746 watt hours given to it, or somewhat less than 59 per cent.

I need not dwell at length upon the uses of the storage battery and the services which it can render in connection with electric light plants, for these are quite generally understood, and new ones suggest themselves all the time. The present rate of demand shows that the uses are at least equal to the rate of supply and sometimes in excess. One application of special interest in this connection, however, is that in connection with incandescent lighting, both from isolated and central station plants, the incandescent light is growing in favor so rapidly that where it is already in use for a certain number of hours during the evening, there is an objection to the use of gas at other times. In small installations it would not evidently pay to run constantly for a few lights. The storage battery would here be very useful, if not indispensable, and a number of local companies who could sell electricity for power in limited amount are also turning to the storage battery; since they are compelled to run during the day to supply electricity for a few lamps and motors, they find it would be as well to run to full capacity, using the balance of power to charge storage batteries from which the energy can be drawn later in the evening, to supply incandescent lamps.

In conclusion, I hope I have succeeded in making a fair presentation of the storage battery case, so far as it concerns the uses and purposes of electric light men. As I have intimated, the storage battery is as far from being perfect as were the first dynamos with which some of the enterprising men of this very body first paved the way to the great industry that now interests so many minds and enlists so much capital. But it is so far perfect, however, that it is ready to help enlarge this great industry to push further ahead in its wonderful development.

Mr. Martin: Mr. Reckenzaun's paper, as I understand, also includes the use of the storage battery, more particularly with regard to its application in street railway service. As he touches upon many points, I presume, that have already arisen in Mr. Mailloux's paper, I would like to offer a motion that Mr. Reckenzaun's paper be now read, and then that the two papers be discussed together.

The President: I presume there will be no objection to that.

ON STORAGE BATTERIES FOR ELECTRIC LOCOMOTION.

By Prof. Reckenzaun.

The idea of employing secondary batteries for propelling vehicles is almost contemporaneous with the discovery of this method of storing energy. To Mr. Planté, more than to any other investigator, much of our knowledge in this branch of Electrical Science is due; he was the first to take advantage of the action of secondary currents in voltaic batteries. Planté is a scientist of the first grade, and he is a wonderfully exact experimenter. He examined the whole question of polarization of electrodes, using all kinds of metal as electrodes and many different liquids as electrolytes, and during his endless researches he found that the greatest useful effect was produced when dilute sulphuric acid was electrolyzed between electrodes of metallic lead.

A set of Plantés original cells was exhibited for the first time, in March 1860, before the Paris Academy of Sciences; scientists admired and praised it, but the general public knew nothing of this great discovery, thus brought to notice. Indeed, at that period little commercial value could be attached to such

apparatus, since the accumulator had to be charged by means of primary batteries, and it was then well known that electrical energy when produced by chemical means in voltaic cells, was far too expensive for any purpose on side the physical laboratory of the telegraph office.

It was twenty years after this exhibition at the Academy of Sciences in Paris, that public attention was drawn to the importance of storage batteries, and that Mr. Faure conceived the idea of constructing plates consisting of lead and oxides of lead. At that time the advantages accruing through a system of electrical storage could be fully appreciated, since electrical energy was already being produced by mechanical means through the medium of dynamo electric machines.

It was the dynamo machine wich created the demand for the storage battery, and the latter was introduced anew to the public at large and to the capitalist with great pomp and enthusiasm. One of Faure's accumulators was sent to Sir William Thomson, and this eminent scientist in the course of experiments ascertained that a single cell weighing 165 lbs. can store two million foot-pounds of energy, or one horse-power for one hour, and that the loss of energy in charging did not exceed 15 per cent. These results appeared highly encouraging; there we had a method of storing that could give out the greater part of the energy put in. The immense development which the electric transmission of energy was even at that early day expected to undergo point to the fact, that a convenient method of receiving large quantities of transmitted energy, and of holding it in readiness until wanted, must be of the highest importance. Numerous applications of the Faure battery were at once suggested, and the public jumped to the conclusion that a thing for which so many uses could be instantly found must necessarily be a profitable investment and plenty of money was provided forthwith, not with the idea of commencing careful experiments, and developing the then crude invention, which would have been the correct thing, but for manufacturing tons of accumulators in their first and immature form.

I need not describe the disappointments which followed the first unfulfilled hopes, nor repeat the criticism that was heaped upon the heads of the early promotors. Those early hopes were untimely and unreasonable. A thousand difficulties had to be overcome—scientific difficulties and manufacturing difficulties. This invention, like most others, had to go through steady historical developments and evolution, and follow the recognized laws of nature, which are against abnormal and instantaneous maturity. The period of maturity has also been retarded by injudicious treatment, but the ultimate success was inevitable. Great advances have been made within the last few years, and I propose now to offer a few facts and figures relating to the present state of the subject with reference to the application of storage batteries to locomotive purposes. It is not within the province of this paper to discuss all the different inventions of secondary batteries, nor to offer any suggestions with regard to priority, therefore I will confine myself to general statements. I am aware of the good work that was done in the United States by Kirchoff, 26 years ago, and of the more recent work of Mr. Brush, of Cleveland, Mr. Julien and others; but I am more particularly acquainted with the recent achievements of the New York Accumulator Company, who own the rights of the Electrical Power Storage Company, of London. I have used the batteries of the latter company for propelling electric boats and electric street cars. The first of the boats was the "Electricity," which was launched in September, 1882, and wich attained a speed of seven miles an hour for six consecutive hours. Since then a dozen electric boats of various sizes have been fitted up and worked successfully by means of storage batteries and motors of my design. The most important of these were the launch "Volta," and another similar craft, which is used by the Italian Government for torpedo work in the harbor of Spezzia. On the measured mile trial trips the Italian launch gave an average speed of 8.43 miles an hour with and against the tide. The hull of this vessel was built by Messrs Yarrow Co., and the motors were manufactured by Messrs. Stephens, Smith & Co., of London. The "Volta," which was entirely fitted by the latter firm, is 37 feet long and 7 feet beam. She draws 2'6" of water when carrying 40 persons, for whom there is ample sitting accommodation. There are 64 cells in this boat; these are placed as ballast under the floor, and actuate a pair of motors and a screw coupled direct to the armature shaft running at 700 revolutions a minute. We crossed the English Channel with this boat in September last year, leaving Dover at 10.40 in the morning, arrived at Calais at 2.30 P. M., stayed about an hour in the French harbor for luncheon and floated into Dover docks the same evening, at 6 30 with full speed; the actual distance traversed without entirely discharging the cells was 54 miles. The current remained constant at 28 amperes until 5 P. M., and it only dropped to 25 amperes at the completion of the double voyage between England and France. Several electric launches are now being constructed in London, and one in New York by the Electric Accumulator Company.

M Trouvé exhibited a small boat and a tricycle, both worked by Planté accumulators, at Paris, in 1881.

The first locomotive actuated by storage batteries was used at a bleaching works in France in 1882. During the same year I designed an electric street car for the Storage Company, and this was tried on the lines of the West Metropolitan Tramways in March, 1883. It had accommodation for 46 passengers. This car had many defects, and I reconstructed it entirely, and ran it afterwards in its improved form on the South London Tramways, and also on a private track at Millwall, where it is now in good condition, and I have a similar car in Berlin. M Phillippart exhibited a car in Paris and M Julien made successful experiments in Brussels, Antwerp and Hamburg. Mr. Elieson is running storage battery locomotives in London. Mr. Julien has also been experimenting with a car in New York, and I believe one is in course of construction for a line in the city of Boston. Messrs. W. Wharton, jr. & Co. have a storage battery car running at Philadelphia on Spruce and Pine streets, and this energetic firm is now fitting up another car with two trucks, each carrying an independent motor, similar to my European cars.

I have mentioned all these facts in order to show that there is a considerable amount of activity displayed in the matter of storage batteries for street cars, and that continued and substantial progress is being made in each successive case. The prejudices against the application of secondary batteries are being rapidly dispelled, and there are indications everywhere that this method of propulsion will soon take a recognized place among the great transit facilities in the United States. I feel convinced that this country will also in this respect be far ahead of Europe before another year has passed over our heads.

There are several popular, and I may say, serious objections to the employment of storage batteries for propelling street cars; these objections I will now enumerate and endeavor to show how far they are true, and in what measure they interfere with the economical side of the question.

First objection: The loss of energy, which amounts in practice to 20, and sometimes 30 per cent. Now, every method of storing or transmitting energy involves some waste, but in saying this we need not condemn the system, for after all the term efficiency is only a relative one. For instance, a 10 horse power steam engine consumes three times as much fuel per horse power hour as a 1,000 horse power engine does, yet this small engine must be, and is regarded as one of the most economical labor-saving appliances known to us. Considered as a heat engine the efficiency of the most economical steam motor is but 10 per cent.—90 per cent of the available units of heat contained in coal being lost during its transformation into mecanical energy. Thus, if we find that the storage battery does not return more than 70 per cent. of the work expended in charging it, we ought not condemn it on that account until we have ascertained whether this low efficiency renders the system unfit for any or all commercial purposes. It is needless to go into figures in order to show that, when compared with animal power, this objection drops into insignificance.

The second, more formidable objection, relates to the weight of storage batteries—and this involves two disadvantages, viz:—waste of power in propelling the accumulator along with the car, and increased pressure upon the street rails, which are only fitted to carry a maximum of 5 tons distributed over 4 points, so that each wheel of an ordinary car produces a pressure of 1¼ tons upon a point of the rail immediately under it.

The last mentioned objection is easily overcome by distributing the weight of the car with its electrical apparatus over 8 wheels or 2 small trucks, whereby the pressure per unit of section on the rails is reduced to a minimum. With regard to the weight of the storage batteries, relatively to the amount of energy the same are capable of holding and transmitting, I beg to offer a few practical figures. Theoretically, the energy manifested in the separation of one pound of lead from its oxide, is equivalent to 360,000 foot pounds, but these chemical equivalents though interesting in themselves, give us no tangible idea of the actual capacity of a battery.

Repeated experiments have shown me that the capacity of a secondary battery cell varies with the rate at which it is charged and discharged. For instance, a cell, such as we use on street cars, gave a useful capacity of 137.3 ampere hours when discharged at the average rate of 45.76 amperes, and this same cell yielded 156.38 ampere hours when worked at the rate of 22.34 amperes. At the commencement of the discharge the electromotive force of the battery was 2.1 volts, and this was allowed to drop to 1.87 volts when the experiment was concluded. The entire active material contained in the plates of one cell weighed 11.5 lbs, therefore the energy given off per pound of active substance at the above high rate of discharge was 62 225 foot pounds, and when discharging at the lower rate of 22.34 amperes, the available useful energy was 72.313 foot pounds, or nearly 2.2 electrical horse power per pound of active matter. But this active substance has to be supported, and the strength or weight of the support has to be made sufficiently great to give the plate a definite strength and durability. The support of the plates, inclusive of the terminals above referred to, weighs more than the active material, which consists of peroxide of lead and spongy lead, so that the plates of one cell weigh actually 26.5 lbs.; add to this the weight of the receptacle and acid, and you get a total of about 41 lbs. per cell when in working order. Seventy of these cells will propel an ordinary street car for four hours and a half, whilst consuming the stored energy at the rate of 30 amperes, or over 5·6 electrical horse power. The whole set of 70 cells weighs 2.870 lbs., which is barely one-fifth of the entire weight of the car when it carries forty adult passengers, therefore the energy wasted in propelling the accumulator along with a car does not amount to more than twenty per cent of the total power, and this we can easily afford to lose so long as animal power is our only competitor. From numerous and exhaustive tests with accumulator cars in this country and abroad, I have come to the conclusion that the motive power for hauling a full-sized street car for 15 hours a day does not exceed $1.75, and this includes fuel, water, oil, attendance and repairs to engine, boiler and dynamo. We have thus an immense margin left between the cost of electric traction and horse traction, and the last objection, that relating to the depreciation of the battery plates, can be most liberally met, and yet leave ample profits over the old method of propulsion by means of animals.

The advantages of storage battery street cars for city traffic are self-evident, so that I need not trouble you with further details in this respect, but I would beg those who take an interest in the progress of electric locomotion to give this subject all the consideration it deserves, and I would assure them that the system which I have advocated in this brief but very incomplete sketch is worthy of an extended trial, and ready for the purposes set forth. There is no reason why those connected with electric lighting interests in the various cities and towns should not give the matter their special attention, as they are the best informed on electrical engineering, and already have a local control of the supply of current needed for charging.

PROF. RECKENZAUN, after reading his paper, added the following remark:

Gentlemen, I hope you will do me the honor to discuss this subject as thoroughly as our time will permit, and raise as many difficulties and objections as you possibly can, and I shall do my best to answer them. (Applause.)

DR. MOSES: There is one of the maxims of this association, unwritten and not in the constitution we adopted to-day, that I think we all have in mind at all times—it is, "Honor to whom honor is due." Mr. Reckenzaun, with a facility that is most amazing to me, in a foreign tongue, has written a very able paper, which, no doubt, will be placed on the files of the association. There is one sentence in the beginning of his paper which I would have him kindly correct before spreading it upon the minutes, which is owing, as I say, to his not being to the manner born, and which will leave an impression that we should not have go forth. He says Mr. Plante turned to profit certain inventions, meaning, simply, took advantage of certain natural effects, or used them—that, I think, to be his meaning. Mr. Plante, though, has never turned to profit a single one of that brilliant series of inventions connected with the secondary battery which have immortalized his name and which caused him to receive a grand medal of honor from the French government.

PROF. RECKENZAUN: I meant scientific profit, doctor. Allow me to repeat that sentence. I say here: "He was the first to turn to profit the action of secondary currents."

DR. MOSES: Would you amend that and say, take advantage of, or use.

PROF. RECKENZAUN: I shall be very pleased to.

DR. MOSES: Now for the shaking up Mr. Reckenzaun asks for. I understand that electric boat of his went so smoothly across the channel. I wish I was there Quite recently I crossed the channel, and it took me the same time to cross—four hours, but it was not at all smooth, so that I am longing for the day when we shall be able to go smoothly across. I got a pretty good shaking up then. There is a question I would like to ask him which is important in its bearings on the running of street cars Will he give us the weight in pounds of the car that he speaks of in Philadelphia, and which he wants us to go and ride upon. We do not want too many of us to go, and for that reason I am anxious to know what the strength of the car is, so that we won't break it down.

MR. RECKENZAUN: I have given the weight of the batteries in this paper. In the car which we use in Philadelphia there are actually eighty cells, because there are considerable gradients to go over. Each cell weighs forty pounds, and the average horse power each is six. Sometimes we only use two horse power, and sometimes, going up grades of 5 per cent., we use as much as twelve horse power, but the average rate is six electrical horse power. With reference to the weight of passengers on the cars, we have never carried more than fifty passengers on that car, because it is impossible to put more than fifty men into it. There are seats for twenty-four, and the rest have to stand on the platform along the step.

DR. MOSES: Another question, if you please. What time does it take you to change your battery?

MR. RECKENZAUN: The changing of the batteries takes three minutes with proper appliances One set of cells is drawn out by means of a small winch, and a freshly charged set is put in. It takes the same time to charge the battery as it does to discharge it in the working of the cars, so one reserve set would be sufficient to keep the car continually moving.

DR. MOSES: Another question, please. What loss of energy have you found accompanies the mere change of a set of batteries?

MR. RECKENZAUN: Our loss of energy right through between the steam engine and the car wheels?

DR. MOSES: No; simply moving the batteries from the car to the depository where it is charged.

MR. RECKENZAUN: Well, the car is pushed into the depot where the cells are being charged. Therefore, there is no moving of the cells required with the exception of just taking them out of the car and pushing a fresh lot in, and one powerful man can tend to that.

DR. MOSES: What is the loss of energy per diem by allowing the batteries to remain unused?

MR. RECKENZAUN: The loss of energy from standing about is probably nothing. If a battery were to stand charged for three months in a dry case the loss of energy might be in three months ten per cent. I purposely had a set of cells standing for two years charged and never used them. After two years there was still a small amount of energy left. So as regards the loss of energy in a battery standing idle, it is practically nothing, because no one would think of charging a battery and letting it stand for three months or a year.

DR. MOSES: That result is exceedingly interesting, because it suggests something that

was done by Faraday in determining the length of time that would elapse before a vacuum would be absolutely destroyed. It was there determined that it would take about one year for a Torricellian vacuum to disappear, so we have this action really verifying that. It is possible to keep it charged in that way for two years, you say, and still allow of some residual charge.

MR. RECKENZAUN: There was a small amount of energy left. There was still electrical energy left after two years. I have had them stand three or four months and I could hardly appreciate the loss going on, providing always that the cells are standing on a dry floor. If the exterior of the box be moist, if it stands on a moist floor, there will naturally be a surface leakage going on; but where there is no surface leakage, the mere local action between the oxides and metallic lead will not discharge the battery for a very considerable time.

MR. POWERS: There is one important matter, the amount of power used. When it requires from 4 to 12 horse power to accomplish the work I would like to know where the loss occurs, if the energy of the street car horse is good for 2 to 6 horse power. I think I shall have a good deal more respect for the horse than I have had before.

DR. RECKENZAUN: I have made experiments in London with a loaded car pulled by two horses. I put a dynamo between the attachment of the horse and the car, so as to ascertain exactly the pulling, measured in pounds multiplied by the distance traversed in a minute. You will be surprised to know that two horses, when doing their easiest work, drawing a loaded car on a perfectly level road, exert from 2 to 3 horse power. I have mentioned a car in Philadelphia where we use between 2 and 12 horse power. Each horse is capable of exerting 8 horse power for a few minutes, and when a car is being driven up a grade, the same as I see in Boston, for instance, pulling a load of passengers up these grades, those 2 horses are exerting from 12 to 16 horse power—mechanical horse power. That is the reason that street car horses cannot be run more than 3 or 4 hours out of the 24. If they are run longer they would be dead in a few weeks. If they run 2 hours a day they will last 3 or 4 years. That is 33,000 foot pounds per minute per horse power.

MR PHELPS: Are you prepared to give an estimate, approximately, as to the life of the cells? How long would it be before they would have to be entirely renewed?

PROF. RECKENZAUN: The life of the cells, if expressed in pounds, the estimate amounts to nothing at all. The life of the cells must be expressed upon the principle of ampere hours or the amount of energy given off through them. Street car work requires that the cells work their hardest from 15 to 16 hours a day. The life of the cells is to be divided first into the life of the box which contains the plates. This box if appropriately constructed of correct materials, will last many years, because there is no actual wear on it. The life of the negative plates will be very considerable, because no chemical action is going on in the negative plate. The negative plate consists almost entirely of sponge lead and the hydrogen is mechanically occluded from that sponge lead. Therefore the depreciation of the battery is entirely due to the peroxydation of the positive plates. If we should make a lead battery of plates one-quarter of an inch thick, it would last many years; but for street car work that would be far too heavy. Therefore we make the positive plates a little more than one-eighth of an inch think. I find that the plates get sufficiently brittle to almost fall to pieces after the car has run daily fifteen hours a day for six months. The plates then have to be renewed. But this renewal does not mean throwing away entirely all the plates. The weight is the same as before, because no consumption of material takes place. We take out peroxide of lead instead of red lead. That peroxode, if converted into metallic lead, produces 70 per cent. of metallic lead, so that there is a loss of 30 per cent. in value. Then comes the question of the manufacture of these positive plates, which I believe at the present day are rather expensive, about 8 cents a plate for the labor only. But I believe the time will come when battery plates will be manufactured like shoe nails and the process of renewing the positive plates will be a very cheap one.

MR. MARTIN: How much is the expense for each car mile, including depreciation?

PROF. RECKENZAUN: I ascertained in Europe that the motive power costs two cents per car mile; that is, the steam power and attendance for charging the batteries. We have to allow twice as much for the depreciation of a battery at the present high rate at which we have to pay for the battery, $5 a box for each cell. But I believe that as soon as the storage battery industry is sufficiently extended, the total cost for propelling these cars will be not more than four cents a mile, or about one-half the cost of the cheapest horse traction.

MR. MARTIN: I have listened to Mr. Reckenzaun's paper with a great deal of interest and attention, and was very glad to have the opportunity of gathering so much information in so short a time and presented so compactly. Mr. Reckenzaun has had a privilege which very few of us can enjoy, and that is of visiting every one of the electric railways in Europe now in operation. His very valuable observations on that subject were recently presented to the London Society of Arts, and presented in so able masterly and exhaustive a manner as to obtain for Mr. Reckenzaun the silver medal of that society. (Applause.) I read Mr. Reckenzaun's paper brought before that society with a great deal of interest, but there was one point which interested me very much, and that was that in Europe, the merits, the claims and the advantages of the cable system did not seem to enter into the consideration of the case at all. Here we have to deal with that problem. The cable is running in this country; it is running in most of our large cities where the storage battery must find its chief scope and play, and unless with the storage battery we can make a better presentation than the cable men can make with the cable and the grip, it is not likely that we shall see the storage battery assume the position and importance which we believe it is entitled to. I have seen various statistics on the subject of the amount of power required for operating a cable railway, and I have seen some of the statements go as high as a loss or waste of 80 per cent. I would like to ask Mr. Reckenzaun whether, since his arrival in this country, he has looked into that subject at all and whether he finds that the loss in getting the current into the storage battery and then delivering it to the motor is less in comparison than that in the use of the cable, in the power finally delivered to the car.

PROF. RECKENZAUN: I have made some very careful observations of the cable tramway in Philadelphia, which is quite an extensive system. I have neer been able to ascertain the exact amount of waste in pulling the cable itself; but I have it on the authority of certain technical papers that there is a waste of about eighty per cent. I do not intend to depreciate cable or any other tramways, but there is a difficulty about introducing cable tramways. It is necessary to dig up the streets and interfere with the roadways. I have been told that the cable arrangements in Philadelphia cost $100,000 a mile, and that the cable road in San Francisco cost more than that. One of the directors of the cable company in Philadelphia told me that if he had seen the battery system before the introduction of the cable, he would probably have made up his mind in favor of it.

The wear and tear in the case of the storage system is also considerable. There is a waste of energy in the dynamo; secondly, in the accumulator charged by that dynamo; thirdly, in the motor which is driven by the accumulator; and, fourthly, in the gearing which reduces the speed of the motor to the speed required by the car axles; because it would be difficult to make a motor run at the rate of eighty revolutions to the minute, which is the number of revolutions on the street car axle when running at the rate of ten miles an hour. Take all these wastes and you find in practice that you do not get more than forty per cent. of the energy given by the steam engine on the car axles. But this is quite sufficient to make this system much cheaper than horse traction.

MR. GEO. W. MANSFIELD, of Cleveland Motor Co.: I would like to ask Mr. Reckenzaun in regard to the waste of energy necessary to carry the storage batteries. Wouldn't it take so many batteries in some cases as to make the weight of the batteries many times the weight of the car? On a level street it would not take so many. Batteries of two horse power might be sufficient, but on a grade of five per cent. it would be necessary to carry twelve horse power storage batteries for probably ninety per cent. of the time. Although I understand that the energy of these batteries would not be used except when needed, at the same time they would weigh a great deal when carrying them through the streets. I have figured somewhat on these problems, and I am still inclined to favor the more direct system. I believe that the time arrives in the history of a city when it is necessary that considerations of beauty should be sacrificed to utility. When necessity demands it, we could run wires overhead through our streets, and running the wires overhead you obviate a number of these lesser losses that Mr. Reckenzaun mentions. Then I would like to ask if he would give us any figures that he has in regard to the rate of loss that he would allow on an average load between the power necessary to the passengers themselves and that to propel the car.

MR. RECKENZAUN: I am afraid the gentleman has either not heard me read the paper, or has got a very bad memory, because in that paper I gave the exact figures of the weights of the entire material used in propulsion, and the weight of the car as a whole. I think I stated that the entire electrical apparatus is one-fifth of the weight of the car when filled with passengers. Then Mr. Mansfield says that we have to carry twelve horse power batteries, because occasionally that power is required. Now, if Mr. Mansfield had made any experiments with storage batteries, he would have found that he could discharge the storage battery *ad libitum*, at the rate of two amperes or two hundred amperes. I can get out of a storage battery almost any horse power I like for ten or twenty per cent. of the length of the line.

I haven't the least objection to a direct system. But when you come to run twenty, or thirty, or fifty cars on one line, you will require such conductors and such electromotive force that it would be impossible to insulate it. The overhead system is applicable to its own particular purposes, to a line running Where there are only five or ten, or even twenty cars running on one line, and that line runs through a suburb or a part of a city, where there are many houses, that system is to be preferred. The objection to the overhead system is not the want of beauty, but the want of practicability. You have to put your posts very high indeed, so as to let great wagon-loads of hay and all sorts of thing pass underneath. And then you find that trouble comes in winter. When it is snowing hard a great many difficulties arise. Yet I would advocate that system anywhere except in city traffic. As regards the loss, suppose that the resistance of the overhead lines is one ohm, to draw one car will take an average of twenty amperes, and the only loss will be twenty multiplied by twenty, that is four hundred amperes through line resistance. But if there are ten cars on that line, you get 40,000 watts loss of energy. unless you increase the conductor in proportion to the number of cars. If you do that, when you get one hundred or even fifty cars, you get an enormous conductor, and have a sort of elevated railroad instead of a telegraph wire, as most people imagine an overhead conductor to be.

PROF. RECKENZAUN said further, in answer to a question put by Mr. Smith, of Jamestown: The current required to run a street car is about thirty amperes, and an electromotive force of about 180 volts. If cars are run in connection with an incandescent light station, we can arrange our apparatus so that we can use an E. M. F., say of 110 volts, and then we can put in a smaller number of cells with a larger capacity that will give a greater horse power. We can charge them with fifty or sixty amperes instead of thirty.

In regard to arc lighting machinery, the arc lighting dynamo cannot be used to charge the accumulators. That is to say they can be used, but they would require such constant attention as to make them impracticable. We can only use shunt wound dynamos for that purpose.

MR. DECAMP: You stated in your paper that you had 80 cells of 40 pounds each. That makes three thousand two hundred pounds. That is for the batteries alone. Now what proportion does the weight of the dynamo bear to that of the batteries?

PROF. RECKENZAUN: It varies. The motors that are used in Europe weigh 700 pounds, for 16 horse power.

MR. DECAMP: Then that 700 pounds is to be added to the 3,200. Now you said that one-fifth of the weight of the car carrying forty passengers consisted of this apparatus. You must be in error in some of your figures, are you not?

PROF. RECKENZAUN: I have figured it out where we are using 80 cells, as in Philadelphia. In Europe we only use 70. They are sufficient for the speed with which the cars are allowed to run there, which is only seven miles an hour. The entire apparatus of a European car, including the motor and the battery, is but two and one-half tons. The total weight of the car filled with passengers is seven tons.

MR. DECAMP: It seems to me there is an error in the figures somewhere. If you are going to double up the load of the street railway car, that is a very important factor in the economy of the system. I had an offhand statement from one of the active directors of the cable system in Philadelphia that just one-half of the power was required to run the cable without any car. Now, if you double that up as you are doing by batteries, see where it will land you in the amount of power consumed.

PROF. RECKENZAUN: I don't understand the doubling up that you speak of.

MR. DECAMP: The weight that you put on in motor and battery, without regard to the extra gearing, is in round numbers 4,000 pounds; but that the car that the cable road pulls does not exceed 7,500 pounds.

MR. RECKENZAUN: I am not aware what amount of loss there actually is in the cable cars. I have given you the weights and figures. Now, with regard to the figures, I have said that I believe that one fifth of the entire weight of the car and passengers is used for the accumulators and motors. I believe the figures are correct.

MR. DECAMP: Another question. You made the remark a little while ago that it took just as long to charge these batteries as to discharge them. I would like to ask a question—how many hours would be consumed in charging a battery of 80 cells if it was run 15 hours? Suppose you charge for a 30 ampere current. That would be 30 times 15, of four hundred and fifty ampere hours.

MR. RECKENZAUN: The batteries have to be charged every three or four hours. They are capable of running 4½ hours on the Philadelphia track; but we prefer to change them every three hours and leave a large margin of charge in them. We should have to exchange the batteries probably as often as the horses are changed.

MR. DECAMP: The residuum, as you call it, is only accounted for once. In all the subsequent charges the battery gets the credit of it.

MR. RECKENZAUN: We never charge them for fifteen hours.

MR. DECAMP: How do you get 450 amperes in?

MR. RECKENZAUN: We don't want 450 amperes. The capacity of those cells is 450 ampere hours, but they are probably charged for 120. When they are returned we charge them as much as they have been discharged. It is very easy to ascertain the amount of energy required on any particular

line. I put an armature on a car and get a man to note down the current consumed as fast as he could write with his pencil. If we took twenty runs over the track he got twenty such tables of current. We have a current for every point on the line, and we average up those currents, and we get exactly how many ampere hours it consumes during that run.

MR. PENDLETON: I understood that the loss of power in drawing the cables in Philadelphia was ascertained at 50 per cent. In San Francisco it was 68 per cent used in drawing the cables, 28 per cent. in operating the cars, and four per cent. in carrying passengers.

In the remarks made by Prof. Reckenzaun I understood him to say that he considered the shunt-wound dynamo essential in charging the storage battery. The last opportunity that I had to speak on the subject of a storage battery was in Boston, in December, 1882. I see some gentlemen present who heard the lecture I delivered at the School of Technology at that time, with the first storage cells which were manufactured in this city. I have had in continual use a dynamo for the purpose of charging storage batteries, but I found it necessary to use a current-breaker in order to avoid the reversal of the dynamo, which at one time bothered me a good deal. I think perhaps there is no other difficulty whatever in using any ordinary series dynamo, although the shunt-wound dynamo has certain advantages for general use.

I am reminded by hearing Mr. Mansfield speak of the direct system of transmission, that about a year ago I was asked the question by the Board of Directors of the Brooklyn City Railway, what the difference in cost was between the direct transmission of electricity for the purpose of propelling cars and the storage battery. It was a complex question, and I felt that it could be solved by a diagram more readily than by language. Therefore, I drew two parallel lines of rails, supposed to be five miles in extent, and I pointed out that the resistance of the circuit when it reached a sum to divide the power developed at the station would make the secondary battery beyond that the most economical. On one occasion, before the New York Electrical Society, where we were debating the subject, I mentioned a method which we had of using direct transmission near the station, charging the batteries and operating the motor by means of a commutation of the battery, and then utilizing the chemical energy at the extreme ends of the route. A storage battery might be able to work far more usefully than by merely exhausting a charged cell. I believe that, under the circumstances, a secondary battery can be made to operate a car for a day or fifteen hours without removal, and only require to be removed when, by extra discharges, the motor became heated or required attention in the battery hospital, which every car station must have.

MR. MAILLOUX: I am interested in the problem of street car traction with accumulators, inasmuch as I happen to be consulting electrician for the company which, I believe, put the first street car propelled by accumulators into commission—a car run on the Madison and Fourth avenue lines in New York city. We have found that it was preferable to use two motors instead of one. We think it would be better to use motors rather larger than necessary, in order to obtain larger effects with a comparatively high efficiency. We use 130 cells, which weigh somewhere in the neighborhood of 3,000 pounds. The whole car, with the motor and batteries, weighs as nearly as possible about six tons, without passengers. This weight is altogether excessive, for which reason the car has very strong iron beams. It was strengthened in Europe, before it was sent over here, with the idea that we might want to carry enormous weights upon it.

One of the other questions that I wished to ask Mr. Reckenzaun was as to the amount of electrical energy per mile that he finds necessary. I have found, as the result of repeated observations, that we must count upon an electrical supply of energy equivalent to from one to one and two-tenths electrical horse power per car mile. This means that if we have a supply of electrical energy equal to, say, 40 electrical horse power hours, we have enough energy to run somewhere between 35 and 40 miles. In practice we do not deem it expedient to exhaust completely the capacity of the car, and we find that a run of 30 to 35 miles is all that it is best to make in the ordinary, every-day work of a car. We find, therefore, that in the average day's run of 60 or 70 miles, it is necessary to change the accumulators twice a day. The car would start with a charge in the morning, and would change somewhere about the middle of its work, irrespective of the number of hours that it had been in operation, because the number of hours run includes the stops. You will see, therefore, that the mere time necessary for changing the batteries becomes quite insignificant, when there are only two sets of them to be changed in one day. So that I do not think the objection advanced by Mr. Pendleton has very much force, in this case at least.

There is another point of interest on which I would like to ask Mr. Reckenzaun a question. In speaking of the duration of the plate, I believe, if I mistake not, that he assumes the working hours of each battery at 15 per day. Now, if they are going to be changed until they will not be working that length of time, does he include in the operation of the battery the operation of charging as well as discharging? Now there is another important thing in relation to the electric railroad. It is the question of braking the momentum by electricity. I found that railroad men, as conservative as they are, when once they conclude to adopt electricity, like to have everything done by electricity on the car; and one of the first questions which they propounded was as to the practicability of braking the momentum by electricity. I know of an electrician who proposed to use the motor in charging a battery while descending a grade, which would produce an intermittent charging. I confess that I do not see very much margin to be expected from this, judging from what has been developed up to the present time, in the way of economy or gain; but I should be interested in hearing the views of so experienced an electrician as Mr. Reckenzaun on that subject. With that car that we are running on Fourth avenue, we were enabled to run up a high grade with a load of some 30 passengers, with an additional car attached containing some few passengers more. But the superintendent was not satisfied with that. He made a stop on the grade, and after stopping a start was accomplished without any difficulty.

MR. PENDLETON: I see that Mr. Reckenzaun is making some notes, and, if the president please, I will say a word in reply to Mr. Mailloux. Inasmuch as the accumulators are so rapidly changed, there cannot be very much difference. Instead of having two sets of accumulators to the car, you would have only a few additional accumulators, which would be a manifest gain. I desire to call Mr. Mailloux's attention to that matter in answer to his remarks.

MR. RECKENZAUN: I am very much obliged to Mr. Mailloux for his complimentary remarks concerning me personally. In regard to using two motors on a car, there are several advantages which it has. I use two motors in every car in Europe, and always have from the beginning. One of them is, that in case of an accident to one motor the other one will bring the car home; secondly, with two motors, we can vary the speed without changing the electromotive force and the battery. If I want very much power I put two motors in parallel, getting four times the power that I do with one machine, and an intermediate power of two motors. There is another advantage of having two motors, and that is, that we have two driving axles instead of one, and we can go up grades with almost double the facility that way, because the adhesion would be double. These are the main advantages arising from the use of two or more motors. You might introduce more eventually, perhaps Mr. Mailloux asked if I would give my experience in regard to the mechanical transmission between the motor and the car axle. I have used almost everything that was known at the time, but in order to give you a full and detailed account of the various modes of transmission which I have used, I should have to give you figures to bear out certain experiments, which I should be able to do only in a lecture, which would take at least five hours, so I hope that you will kindly excuse me on that point. With regard to the durability of plates, I have taken into consideration fifteen hours a day. In regard to the application of electrical brakes, I will say that that was one of the first ideas that entered my head when I began to use electric motors, and people had that idea long before me. It was not original with me at all. I have used an electric brake, using the motor itself as a brake—that is, as the car runs down a grade by momentum it generates a current; but this current cannot be used for recharging a battery. It is utter nonsense to talk about that unless we have a steady grade four or five miles long. The advantages are very small, indeed, and the applications which would be introduced by means of automatic cut-outs and governors, and so on, would counterbalance anything that might be gained. As regards going up an incline, of course stopping and starting again has to be done often, and anybody who at any future time makes cars to work by electricity, whether they have storage batteries or not, has to make sufficient motive power to overcome all the difficulties that any line might present. One of the great mistakes which some of the pioneers in this direction made was that they did not put sufficient power upon the cars. You always ought to put on the cars power capable of exerting, perhaps, 20 or 30 or 40 or 50 per cent. more than is ever demanded in the ordinary street service, so that in case of being snowed up, or any other accident which is liable to occur, you would have plenty of power to get out of the scrape. Mr. Pendleton made certain suggestions in regard to a combined system of conductors and accumulators. I do not know much about those, and I could not give an opinion unless I had studied the matter thoroughly.

ELECTRIC MOTORS.

MR. S. A. DUNCAN: At the last meeting a committee was appointed to prepare statistics in regard to the number of motors in operation at central light stations, the prices paid, etc. A circular was issued; some of the companies responded, but a very large proportion did not respond. One member of the committee, however, in New York, paid particular attention to the New England States, and collected a large amount of valuable information which he promised to have with him here on Monday evening, and to meet the other members of the committee. However, that information and the gentleman himself have not arrived, and the papers which I have contain some information which I do not think should be published unless through the hands of the executive committee. It gives information regarding charges, etc., of some of the local companies which it might not be judicious to spread out for general information, and, therefore instead of preparing a written report. I ask the privilege of making a motion to refer those papers to the executive committee so that they shall pass upon them, select such data from them as they may think best, and have them distributed for information. I make the motion, and ask for the discharge of the committee.

The motion was carried.

The committee appointed to recommend a place for holding the next meeting of the association submitted the following resolution, which was adopted:

RESOLVED, That the next meeting of this association be held in the city of Pittsburgh at such date in February as the executive committee may determine.

Dr. Otto Moses, Mr. Stephen Holbrooke, and Mr. F. A. Gilbert, presented their resignations as members of the executive committee, which on motion were accepted.

DR. MOSES stated, in tendering his resignation, that he was a member of the executive committee for one year, of which only half the time had elapsed, but as it was important that the executive committee should be appointed as much as possible from the neighborhood in which the next meeting is to be held, he thought it advantageous that some one in that locality should be substituted for himself.

Mr. S. A. Duncan, of Cleveland, Mr. T. Carpenter Smith, of Allegheny City, and Mr. Wells W. Leggett, of Detroit, were nominated as members of the executive committee to take the places of the gentlemen who had resigned, and there being no objection the secretary cast the ballot of the association for the persons nominated.

UNDERGROUND WIRE.

MR. LEGGETT: I believe that it was stated at the opening of the meeting that we would talk up this matter of underground wires at the close of the session. I desire to state what position we are in at Detroit. At Detroit, as most of you gentlemen are aware, having seen our city, we are lighted by the tower system. We have some four hundred miles of wires in our system there. Just at the present time our City Council, our Board of Trade, and our Mayor, all of them very excellent gentlemen, who have at heart the welfare of our city (and there is no question but that they have at heart, also, the welfare of our company), have deemed it expedient on their part to immediately stop the operation of running the wires underground. Now, we are met with this condition of affairs that we do not know what to adopt. We would be very glad to have the views of this convention, or the views of such members of it as have had experience in this line, and to know if there is any system which any one can recommend that is beyond the experimental stage. We have invested in the city of Detroit nearly half a million of dollars in our plant, and you can readily see that we are driven to an extremity. That, of course, to us, is a matter of very grave importance. We want to know whether we are obliged to take one of a number of things, each of which is experimental, or whether there is some system which some person, some member of this association, can say that he has found to be expedient and practicable throughout for this purpose.

I must confess that after all our investigations in this matter we are as yet entirely undecided to know what to do. We recognize, as well as our Mayor, our Board of Public Works and our City Council, that this matter of overhead wire is becoming a very serious one, interfering with fire ladders, causing more or less danger to property and to person; but the remedy is what we are seeking. If there is anything which we can adopt, we would be glad to adopt it; and for that reason I hope that there will be short remarks from a number of sources, the experience of different individuals in this line, whether there is anything that they can recommend directly. And I should also be glad to know of the difficulties that they had experienced in regard to the matter. I would like very much if Mr. DeCamp would state briefly whatever experience he may have had with the matter in Philadelphia; and if we have a representative in the room from the city of Brooklyn, I would also like to hear from him.

MR. DE CAMP: All that I can do is to state the facts of the case as it exists in Philadelphia. As Mr. Leggett says, it is certainly, with us, not beyond the experimental stages. There has probably been more work done in that direction in the city of Philadelphia than in any other city in the country, and this is the condition of it: The department known as the Electrical Department of the City of Philadelphia, about a year and a half ago, made an appropriation of $5,000 to put down a line about a mile long. A lead-cased cable was put in, well insulated, put in a trough; the trough was filled up with residuum of petroleum. That carried twelve lights of thirty volts each, which was the extent of that particular line. At the end of a year, about, a further appropriation permitted the department to extend its line. It, however, was not extended in a double line; the balance of the circuit was made on one side of the circuit, and the other was taken overhead. That has been in operation about six months. It is now carrying a load of forty-five volts each, and has been doing that for probably the last three months. The cable is working fairly well, but from various causes has had more or less grounds on it—very many more than the overhead circuit. Additional experience was recently had at South street, where there was a circuit of one mile put in. The first circuit put in was taken up for some reason or other, it being a failure. The cable which is there to-day is a good one, but the superintendent tells me that the grounds are so numerous that he hardly knows where he commences to pick them out, and there they are to-day in that condition. Whether it is the fault of the cable, or of the conduit, or of the work done, I do not know. That, however, has brought us to this conclusion, that we have got to replace all of that before we shall be justified in running lines over such a circuit.

The sectional underground wire operated by the Electric Light and Power Company, of which company I am the manager, is the latest experiment in the way of underground electric lighting which we have in Philadelphia. I have been manager of that company for six months. The gentleman in charge of that is a clever man, and a man of more practical experience in the operation of underground wire, I think, than almost any other man in the country. He is a man of exceptional intelligence, and is an enthusiast in his work. He has left no stone unturned to look into the difficulties which we have experienced, and to try and foresee them. The conduit itself I believe to be one of the best structures in existence. I am speaking now merely for its convenience. It is an iron conduit. Previous to my taking charge of it, I do not know how many cables they had in. I do not know how they were selected, certainly with the best judgment that the company then possessed.

MR. A. H. BROWN, of Chicago: I have had about eighteen months experience with underground work in Chicago. We have there the Dorset conduit, and are troubled greatly with gas, and have had two or three explosions, although they have not caused much damage. We find that the principal trouble with the conduit is at the joint. We think if a perfectly tight conduit joint could be made that we would not be so much troubled with gas and even water that leaks in. The newest conduit which we know of in Chicago is the Hurlburt conduit, which has a flexible joint. It has been on the market but a short time, and I do not know that any of it has been laid. But it seems to me that it would carry out the expectations entertained regarding it, from the fact that the joint is flexible. We have man-holes at an average distance of 400 feet apart, and between the man-holes we find that the conduit sags after it has been laid any length of time from the pressure from above—the street traffic. We have some sixty or seventy miles of wire under ground, and in that quantity nearly all classes of cable under-

ground wire are represented. We tried lead covered cable at first, and finally thought it was best to give that up, but lately have gone back to it. We find that in places lead covered cable fills the bill. On our main circuits running from the station we think it is best to make them of lead with white joints, and after we leave the conduits running through the laterals under the sidewalks, we find it would be best to have something besides lead cable, because, as you know, on all arc light circuits we have to get them everywhere and anywhere at all times to put in and take out lights. Lead-covered cables I don't think quite fill the bill under the sidewalk. We find it necessary, as I say, to have white joints on the lead cable, and when we do leave the conduits, to leave lead cable for good and put in some other wire. We also have great annoyance from the rats. They eat the lead of the cable. You can see where their feet burn on the cables, and their tails, and we find them on the ground with their noses burned off.

MR. J. A. POWERS: I have been in the past year somewhat interested in this underground question. The principal cities of the State of New York, outside of New York and Brooklyn especially, have been greatly exercised during the past year on account of the interference of the wires with the ladders of the firemen at the Buffalo Hotel fire, and on account of that a number of bills were introduced and two or three were passed by the Legislature and signed by the Governor, allowing wires to be put underground with the consent of the local authorities. We told the contract board of the city of Troy that we would forsake our contract and would make no contract with them under any conditions that did not contain a clause eliminating the underground business. In other words, that our contract should be binding as long as our wires were overhead. Unless we are going to have a great deal of trouble in the small cities especially, it is necessary for the electric light men to take an uncompromising attitude. People say that because they want the wires underground is a sufficient reason why they must go underground. That is all they know about it. A prominent paper of the State of New York actually urged as an argument that because an Edison Company in the city of Albany put their wires underground that we in the city of Troy should put our wires underground. Now, in that state of ignorance it is the business of this convention to enlighten people on that subject as much as possible, and also to take the most uncompromising attitude toward forcing the wires underground. Let them understand that it is not possible in the present state of the art, especially where lights are spread over a large area.

MR. DECAMP: Mr. Powers' remarks call to my mind a little early experience I had with legislative matters. About the first year we started there was a bill brought up in our council taxing overhead wires. It was put $5 a mile for telephone and telegraph wires and $12.50 a mile for electric light wires. I said, gentlemen, I do not understand that; why should an electric light wire be taxed more per mile than a telegraph wire. One of the members turned around and said: What is your name? Where are you from? And then he moved to amend that by making the tax on electric light wires $15 a mile. That is the way your arguments, so far as this is concerned, are met.

The secretary read the following from Mr. F. E. Kinsman:

"Cannot the question of protection for lightning arresters be considered at the next meeting of this body?"

THE PRESIDENT: If Mr. Kinsman will talk with Mr Keilholtz, of Baltimore, he will get some very valuable points on that subject.

MR. LEGGETT: I would like very much to hear from the president on this subject, and what experience he has had in Baltimore.

THE PRESIDENT: We have not had any. I have declined for a good many years going before legislative or municipal committees, for the simple reason that it is only a question of cost as to the feasibility of placing wires underground. It is a question I do not care to debate, because we do not want to put our wires underground. It costs too much.

MR. LEGGETT: That is just the information I wanted to arrive at.

THE PRESIDENT: Very expensive, sir, but entirely feasible.

MR. LAW: In Philadelphia we have had considerable trouble in conduits from the explosion of gas. In Philadelphia our lines are erected on iron poles made of gas pipe, and in two places lately we have cut holes in those poles and connected them with the conduits. I noticed that there was a considerable escape of gas from the top of those poles. I was up one of them the other day examining it and it is very perceptible—quite strong—and I would like to ask if there have been any experiments made in that direction.

DR. MOSES: There is a little matter, but one of great importance—as trifles sometimes have a most important influence—there is a little thing that might be reported upon at some future meeting, and that is the influence of electric currents, both continuous and alternating, on small masses of magnetic matter and on the demagnetization of the same. That is intended to cover the question of the rapid magnetization and demagnetization of small masses of iron used in measuring instruments, and also what is the effect of currents, large and small, upon watches, which are in everybody's pocket, and whether it is possible for them to be demagnetized, when once they are really magnetized, by any appliances we have. It is a question of great importance, when you consider that the first chronometer that went accurately was the means of bringing the inventor a reward of 20,000 pounds from the British Government. You can see it is a matter of importance to have timepieces absolutely accurate for certain purposes. All of the chronometers used on board ship contain masses of iron in them, and it would not be pleasant to have somebody come down on an electric light company for causing the magnetization of the chronometer, and thereby bringing about the loss of a ship.

DR. MOSES' motion was carried.

THE PRESIDENT: I appoint on that committee Dr. E. Lange, of Pittsburgh. I will appoint on the Committee on Insulation, etc., to take the place of those who resigned, Prof. Elihu Thomson, of Boston; Dr. Otto Moses, of New York; Dr. L. Waldo, of New Haven; Dr. Duncan, of Baltimore; E. Lockwood, of New York; George A. Hamilton, of New York; O. M Shallenberger, of Pittsburgh.

PROF. THOMSON: I thank the President for the honor of being appointed on that committee. I will endeavor to collect all the information I can in regard to this subject, with the assistance of the other members of the committee.

MR. DUNCAN: If there is no other business before we adjourn I would like to call the attention of the convention to one point. I was not present yesterday morning when the report of the carbon committee was presented, and it seems to me that there is one point which interests local lighting companies which has been passed over without very much consideration, and in that connection it seems to me it would be well to take some action preparatory to the next meeting, to look into this question of carbons very thoroughly, either through the executive committee or by some special committee, because if we have got to break down a pool every two months we ought to be in shape to do it, and it seems to me that from the information which has been going around—not in the convention itself, but from mouth to mouth—in regard to the formation of an organization and the prices desired to be obtained by the old pool, that the time has arrived for the companies interested here through the committees of this association, and through its proper officers, to look after that subject very carefully. It seems that we have been able in the past to get along very comfortably with the pools, but I can conceive of circumstances where it might take considerable time to break up a combination. If that is the case it seems to me it would be well to have either a special committee appointed or the matter referred to the executive committee to keep it in hand. As I understand, the committee that reported yesterday morning was discharged. If they were discharged I should make a motion that a committee of three or five be appointed to take this matter in hand, and that all papers pertaining to carbon be referred to that committee for report at the next meeting, and that they have power at any time to call the attention of the executive committee to any proposed action such as has taken place within the last few months. I think it is high time that we protect ourselves as well as the parent companies protect themselves in the manufacture of carbon.

The motion was seconded.

At the request of the president Mr. Duncan put his motion in writing as follows:

"RESOLVED, That a committee of three be appointed by the chair to inquire into and report on all matters pertaining to the carbon matter."

The resolution was adopted.

THE PRESIDENT: I now declare this convention adjourned, to meet in Pittsburgh on a date in February to be hereafter determined by the executive committee.

There was not a single hitch in the excursion down the bay, factory visit and banquet. This speaks volumes for the management. It is difficult to provide that all guests shall be so treated and a programme so closely and thoughtfully planned that not a single item of expense or annoyance shall appear, but on this occasion from the time of leaving the Parker House at 12 30, until the return to the city at midnight, not a single expense was permitted on the part of any visitor, nor was there the slightest incident to mar the occasion, which was a triumph of entertainment.

CONVENTION NOTES THAT EVERYBODY WILL READ.

It was the greatest convention, and Boston should feel proud.

To Pittsburgh next winter and to Cleveland next summer seems to be the desired programme.

The Simplex arc lamp running on the Edison incandescent circuit was shown in the café of the Parker House, and admired by all who saw it.

The Bernstein Electric Light Company, Boston, was represented by Messrs. Cram and Bussman. A number of their large incandescent lamps on the arc circuit were on exhibition.

The agents of the Thomson-Houston Company had all been called in and proved to be a keen, vigorous and thoroughly wide-awake electrical staff, such as any company should be pleased to have with it.

"E. R." were the letters over the entrance to the ELECTRICAL REVIEW parlors, composed of a number of ½ candle power incandescent lamps of the Sun system. The effect was unique and attractive.

The new England Telephone Company very thoughtfully placed a free telephone in the rooms of the Executive Committee. Mr. A. H. Chapman, of the company, was present during the sessions and assisted in the Boston welcome.

It was greatly regretted by many of the visitors that the necessary absence of Mr. W. J. Hammer, at the meeting of the Edison agents at Altoona, prevented them from visiting the interesting stations of that company in Boston.

Mr. S. A. Duncan, of Pittsburgh, a valuable member, was made Chairman of the Executive Committee, and he, with Mr. T. C. Smith, of the same city, may be counted on to see that the Pittsburgh Convention is a well-rounded success.

The Vitrite and Luminoid Company of New York, had a number of their lamps on exhibition. A very pretty display of the lighted lamps was made in the hall fronting the elevator. Mr. Romaine Mace represented the company most agreeably.

The Standard Cable Company, of Pittsburgh and New York, was, as before, represented by Mr. Geo. L. Wiley, who has a full line of samples of cables, insulated wires, etc., which were investigated by the usual large number of interested visitors.

The New England Glass Company was represented by S. O. Richardson, who has a large acquaintance among electrical companies. Mr. Libby, of this company, was absent for the first time, having been compelled to go to Europe several weeks ago.

Mr. Eustis, of the Committee on Wire Gauge, remarked that it might be interesting to some to know that 30,000 figures were used in tabulating the gauge, and as this work was done three times, the whole number of figures amounted to nearly a round 100,000.

The daily editions of *Modern Light and Heat* were much sought after, and contained full stenographic reports of the work of the convention. This was a great undertaking, and Messrs. Ransom and Ross, the editors, are to be congratulated on carrying the heavy work through so successfully.

Mr. Webb Hayes, son of the ex-President of the United States, has been a close observer of the proceedings of the last two conventions, and has made many friends by his quiet, gentlemanly qualities. Mr. Hayes is an active participant in the business of the National Carbon Company of Cleveland.

In Mr. Coffin's splendid speech, the officer of the U. S. Army alluded to is Lieut. Gilman, son of Col. Gilman of the U. S. Army, at Washington. Lieut. Gilman is now with Mr. Barton, of the Thomson-Houston Company, at Chicago, and is rapidly working his way to the front in the great field of electric lighting.

Electric current was furnished free to all who wanted it by the Boston Electric Company and the Sun Company. The demands at this convention were far greater in this respect than ever before, and the work of the companies in so promptly satisfying those demands is deserving of most honorable recognition.

A little gathering in the rooms of the Okonite Company on Thursday, surprised Mr. Fred A. Gilbert with a testimonial, Mr. Frank Ridlon gracefully making the presentation speech It is such little favors one receives as evidence of appreciation and thoughtfulness of friends that brings new anticipations and bright thoughts of success in future ventures to the minds of recipients.

Mr. C. J. H. Woodbury participated in the ride down the bay, and was a valuable guide in pointing out to the visitors the many places of historic interest which abound in Boston harbor. The point where the tea was thrown overboard by our enterprising and independent forefathers seemed to possess a particular fascination for the guests from distant points.

The three hundred copies of the ELECTRICAL REVIEW which arrived from New York 6 30 A. M., Thursday, containing a condensed yet comprehensive report of the proceedings of the convention up to Wednesday afternoon, were in such demand that not a single copy was left by Thursday evening. The papers were not distributed, but were kept in the REVIEW parlors, a copy being taken by each caller.

The game of "hearts" was indulged in by several of the visitors in their hours of leisure. The keeper of the score in this game has quite an advantage, and, in one instance, when it fell into the hands of an artistic and conscienceless scorer from Connecticut, assisted by another trained in figures and electrical supplies from New York, an innocent Washingtonian and his friend found, when too late, how deep the depravity of man could descend. It is currently reported, if Standby and Badyear don't settle that sixty-six cents with Rejoice and friend, a challenge *a la* Boulanger will promptly issue.

THE BAXTER MOTOR.

It has been stated by eminent electricians that it was impracticable to operate series motors on arc light circuits. The contrary has been proved by the Baxter motor, which is built from ½ to 15 horse power.

A 10 h. p. was used to drive a 50 light Sawyer-Man incandescent dynamo, and the steadiness of the lights proved the success of the system. Fans, a printing press, blower, sewing machines for boot work, were shown in practical operation. The government of these motors is effected at practically no loss of energy, a centrifugal governor throwing in or out coils of the field. The regulation left nothing to be desired. The exhibit occupied three large parlors on the first floor of the Parker house, engaged some twenty-five operators, and was an animated and interesting scene, the rooms being continually crowded with interested visitors. No such motor exhibition was ever witnessed.

THE THOMSON-HOUSTON EXHIBIT.

The exhibit of the Thomson-Houston Company at the Parker was well worth an extended visit. There were shown four distinct systems of incandescent lighting, multiple series from arc light circuits, series from arc light circuits, multiple arc, alternate current transformer for long distance lighting. For the last, a twenty-five light transformer was supplied with current from the Congress Street station of the Boston Electric Co.

A novel form of arc lamp has just been brought out, thirty-two inches in length, and adapted to low-ceiled rooms. With single carbon it burns 4-5 hours; double, 8-10 hours.

Two motors, one 1½ horse power, runs at 3,400 revolutions; another, a 5 horse power, runs at 1,500 revolutions per minute, arc adapted for 110 volt circuits, are shunt-wound and regulate from no load to full load within 2 per cent. Commutators for various types of machines, switches, cut-outs, voltmeter, ammeter, potential indicators, ground detectors for two and three wire systems, jigs and gauges for turning commutator sections, and filing and adjusting brushes, show the completeness in every detail of the Thomson-Houston system. The exhibit was a perfect one, and was a leading point of attraction during the convention.

Meeting of Electric Light Agents.

The Thomson-Houston Electric Company gave a dinner at Young's Hotel, Boston, Thursday evening, to the many agents and operators of the Thomson-Houston system who had been called to the city by the Electric Light Convention. Thirty-five covers were spread and there was not a vacant chair. Three hours were most enjoyably passed, and mixed in with the social pleasure was much valuable discussion relating to the company's work and plans for the future. Prof. Thomson was present, and proved an inexhaustiable fountain of information to the many workers in the outside field. The idea of the dinner was a most happy one, and it was enjoyed by an assembly of alert, vigorous gentlemen who will not fail to profit by it.

The Electrical Clam-Bake.

Along the line which for nine years past has been so pleasantly sprinkled with Eugene Phillips' clam-bakes, no more successful one has been held than the one of August 12, given at the Vue de l'Eau. The spot is a most delightful one, the ride down the bay, the view from the grassy, elevated grounds most charming, and, to complete the effect, the day was everything that could have been desired. The attendance was the largest ever seen at these clam-bakes, the clams were never better, the football never more active or ubiquitous, and, as a consequence, the enjoyment was never more pronounced, and when the day's work—if we may use the word—was done and well done, the three rousing cheers and song of "For he's a jolly good fellow," that greeted the big-hearted host, should make him feel that his many friends are not lacking in hearty appreciation. It is a remarkable fact that in the nine years that these clam-bakes have been such an agreeable part of the electrical growth of the country, each and every one has had fair weather, and the conclusion is easily reached that the American Electrical Works hold intimate relations with the clerk of the weather. It may be he has enjoyed one of the clam-bakes, and that at once explains why he regards them with so much favor. For that matter, Providence has always been near them. At the clam-bake dinner, Dr. Otto A. Moses presided as toast-master with his usual grace, and the cheerful manner in which he would call out the gentlemen present and make them respond, was as entertaining as it was paralyzing, at times, to the gentlemen called. Among the gentlemen responding was H. C. Davis, president of the Electric Club of New York; Frank Ridlon, president of the Boston Electric Club; and Messrs. Lockwood, Ransom, Reckenzaun, Alexander, Pope, Dr. O'Donahue, and others. A toast was given to Mr. John I. Sabin, of San Francisco, who could not be present, but accompanied his regrets with two baskets of champagne, which were disposed of in electrical style.

There were the usual pleasantries, in which figured wax cigars, paper ginger-snaps, and imitation fire-crackers, all deftly concealed with the real articles. The menu was tastefully gotten up, and concealed in a large imitation fire-cracker.

Visit to a Great Electric Light Factory.

On the visit of the National Electric Light Association to the factory of the Thomson-Houston Company at Lynn, the company, in parties of twenty, were taken in charge, as each barge reached the factory, by one of the experts of the company. In the first room men were at work upon the heavy parts of the dynamos and motors. There were special tools for boring bearing and field, so that the armature would be perfectly aligned when placed in the machine. In the arc dynamo testing room were seven machines running at full load. They are thoroughly tested for one or two days, before leaving the factory. The incandescent dynamo testing room contains a furnace in which all armatures are backed, after receiving repeated coats of shellac. Fourteen special machines, used for the manufacture of lamps, are continually in use. Large banks of lamps on the ceiling gave a cheerful appearance to the scene. One of the company's 600 light alternate current dynamos was seen in operation, and armatures for others of the same type in process of construction. The armature makes 1,500 revolutions per minute, has 10 spirals of wire on the surface of the drum, and corresponding to the number of pole pieces. But one layer of wire is used, and fully 90 per cent. is active. The lamp room is crowded with lathes, drills, reamers, and special tools. In one corner a gang of men build up the lamps from the finished parts. In the lamp testing room, holding 170, the employes find their skin tans to a brown so much desired by the fashionable athlete. The manufacture of transformers for the alternating system occupies another room. In the pattern room there were patterns for a 1,000 light alternate current dynamo and a 25 horse power motor. Near by is the private laboratory of Prof. Thomson, where ⅜ inch iron rods were welded in the presence of the visitors by the new process invented by Prof. Thompson.

In the winding room there were seen miles of wire in coils and arc armatures and fields in parts and in the finished form. Barrels of lamp fittings, buffing and burnishing machines and lathes and apparatus for the manufacture of incandescent fixtures take up the room adjoining.

A very compact 15 horse power railway motor was in process of construction, and other sizes both in castings and in the finished form for stationary use. A part of this room is separated by a wire screen, and in it are collected parts of machines. When sufficient have been accumulated they are sent to the assembling room Passing to the incandescent lamp-testing department there are lamps for multiple arc circuits (direct or alternating current) and 32 to 125 candle power series lamp. The lamps are so uniform that seldom any sorting is needed. Next are seen two and five horse power motors in operation. To one was attached a speed indicator, and a slight movement of the needle could be noticed at the beginning and end of the stroke of the engine, making 80 revolutions a minute. Converters of various sizes were ready for shipment. The room adjoining, devoted to instruments and measuring, is lighted by lamps on converters. A view of the factory is given on this page.

The Convention of Edison Illuminating Companies.

We notice the following concise statement in the Altoona, Penn., *Tribune*, of the 11th inst.:

"In the Library Hall of the Logan House, yesterday morning, were begun the sessions of the semi-annual meeting of the directors, managers and other officials of the Edison Electric Illuminating Companies of the United States, the subordinates of the parent company, the main office of which is in New York city. The object of the meeting is to exchange views and ideas and to confer with the officers of the parent company on all matters on which advice may be needed. At the meeting held yesterday, forty-one companies were represented by sixty-four representatives, and this number is expected to be increased to-day to such an extent that seventy-five representatives will be in attendance from sixty local companies. This is about three-fourths of the entire number of companies in the United States. The large attendance is due to two facts. First, to the increased interest manifested in the practical use of electricity; and second, to the great and good results which have in the past been attained from these semi-yearly meetings, where so much of interest to the various companies is discussed. The attendance at the present convention is double that of any yet held. Sessions were held yesterday morning, afternoon and evening, and there is a likelihood that as many will be held to-day. Officers are elected yearly, and yesterday, John I. Beggs, formerly of Harrisburg, but now of the New York company, was elected president; J. H. Vail, of New York, secretary, and Wilson Howell, of New Brunswick, N. J., treasurer. The Edison Electric Light Company, of this city, is being represented at the meeting by its president, A. J. Anderson."

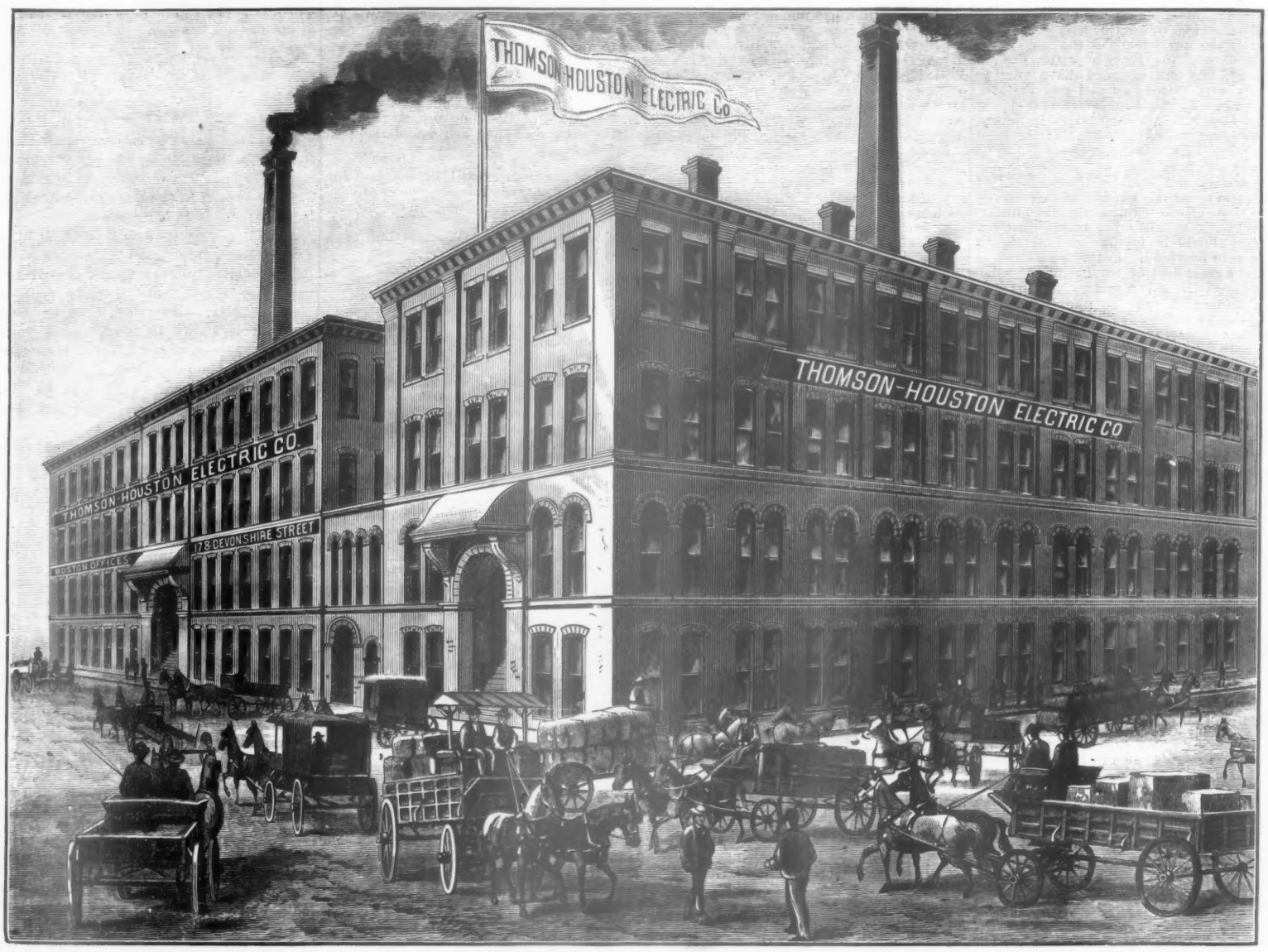
Among the matters of special importance to the Edison interests were careful papers on the municipal system of street lighting by Edison lamps; the accumulator as an adjunct to central stations; the distribution of current for electric motors; residence lighting; the relation of the high economy lamp to central station lighting; central station apparatus. In connection with the storage battery discussion, the convention was favored with an instructive informal address by Prof. Dudley, chemist and electrician of the Pennsylvania Railroad, summarizing clearly and practically the results of the experiments of the past two or three years in the lighting of cars.

The discussion of the present status of the litigation for the support of the Edison patents called out the following expression, which was unanimously adopted:

WHEREAS, The present status of the suits prosecuted by the Edison Electric Light Company, against the infringers of their patents (which suits have in some cases been several years in the courts), has been fully stated before this convention, and

WHEREAS, We, having been licensed to hold exclusive rights in our respective territories, have thereby acquired a partnership interest in the general prosperity of the Edison Electric Light Company, as depending upon the validity of the patents for our protection against the destructive effects of unscrupulous competition,

RESOLVED, That we, the Association of Edison Illuminating Companies, in convention assembled, desire to express our hearty commendation of the energetic efforts and policy of the parent company and the progress which has resulted, as shown by an exhaustive report made to us by President Johnson.



NEW THOMSON-HOUSTON FACTORY AT LYNN, MASS.

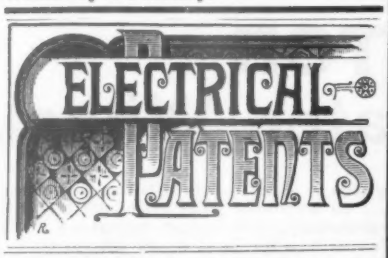
RESOLVED, That we extend to the Edison Electric Light Company our cordial moral support, and an assurance of our conviction that the present unprincipled rivalry now affecting some of the local companies here represented will be speedily terminated by decisions in favor of the Edison patents, thus bringing to justice all who have ignored the rights granted by the patent laws of the United States to the Edison Company, as the heirs of Mr. Edison's electric light inventions.

A discussion of proper methods in interior wiring of buildings, called out, among others, the following expression:

RESOLVED, That in consequence of the fact that "Underwriters" wire, so-called, has been shown by experience to be unreliable and treacherous in its action, and we regard its use as introducing injurious possibilities in all interior wiring, we discountenance its use and urge upon the attention of the companies representing this association the desirability of abolishing it entirely in the work of wiring buildings over which they severally exercise a control.

The occurrence of the Edison and the National Conventions on the same dates was referred to, and the members were informed that E. R. Weeks, Vice-President of the National Association, also a member of the Edison fraternity, had stated at Boston that the time of the Edison sessions is fixed by their constitution, and that future meetings of the National Association would be determined with this in mind, so that no inconvenience may be experienced in future by any who desire to attend both.

The next semi-annual meeting of the companies will be held in Chicago, on the second Wednesday in February.



INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING AUG. 9, 1887.

367,662 and 367,663 Programme clock; Andrew J. Reams, Augusta, Kan.

367,667 Wire drawing machine; Wm. H. Sawyer, Providence R. I.

367,670 Electric light switchboard; Charles E. Scribner, Chicago, Ill., assignor to the Western Electric Company, same place.

367,685 Electro-magnetic railway brake; Charles J. Van Depoele, Chicago, Ill.

367,705 Galvanic battery; Paul Raoul de Fanchaux D'Humy, London, England.

367,730 Cable rack for switchboards; John A. Seely, New York, N. Y.

367,731 Deposition of platinum by electricity; William A. Thoms, London, county of Middlesex, England, assignor to the Bright Platinum Company, same place.

367,734 Terminal for electric cables; Robert H. Widdicombe, Chicago, Ill., assignor to the Western Electric Company, same place.

367,841 Electric gas-lighting system; George F. Perkins and John P. Hurley, Holyoke, Mass.

367,866 Coupling dynamo-electric machines; Elihu Thomson, Lynn, Mass.

367,898 Magnetic clock; Daniel Drawbaugh, Eberly's Mill, assignor to Edgar W. Chellis, Harrisburg, Pa.

367,901 Arrester for electric circuits; James P. Freeman, Chicago, Ill., assignor to Saml. M. Bryan, Washington, D. C.

367,925 Electrical annunciator; William C. Poole and John Schnepf, New York, N.Y.

367,931 Electric coupling; Charles Runels, Lowell, Mass., assignor of two-thirds to Henry Runels and George W. Rand, both of same place.

367,934 Commutator for electric generators; Oliver B. Shallenberger, Rochester, assignor to George Westinghouse, jr., Pittsburgh, Pa.

367,956 Bending clamp for battery electrodes; Horatio J. Brewer, New York, N. Y.

367,960 Electric clock system; Charles L. Clarke, East Orange, N. J., assignor to the Telemeter Company, of New York.

368,066 Railway signal; Irving H. Brown, New York, N. Y.

368,088 Enclosing case for electric machines; Charles H. Hinds, New York, N. Y.

368,099 Primary battery; Samuel W. Macquay Tedworth square, London, England.

368,136 Cable hanger; Frederick E. Degenhardt, Chicago, Ill., assignor to the Standard Underground Cable Company, Pittsburgh, Pa.

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BUSINESS NOTICE.

"In making the statements which follow we can verify each and all of them as facts. Mr. Edward P. Thompson, of Temple Court (7 Beekman St.,) New York, is a good man to bring your patent cases to, for he is thoroughly versed in all the ins and outs of a Patent Attorney's duties. The following are some of his qualifications: Graduate of Stevens Institute as Mechanical Engineer. For four years tutor of classes of young men in mathematics and experimental physics at Elizabeth, N. J. Served professionally as Electrician and Chemist in the Swan Electric Company of New York for two years. Because of past successes as a Patent Attorney at 13 Park Row, New York, was appointed to succeed N. S. Keith, of the patent agency of the *Electrical World* and Associate Editor. N. S. Keith is known as the Translator and Reviser of Schellen's Treatise on "Dynamo Electric Machinery." Mr. Thompson for two years personally prepared and prosecuted all the patent business of *Electrical World's* Patent Agency, and is the author of a series of articles in said paper upon "Analytical and Systematic Method of Inventing," which were widely known and favorably received. Mr. Thompson is a member of American Institute of Electrical Engineers and American Society of Mechanical Engineers. He is author of the "Expansion of Polynomials," which the ablest mathematicians of the world universally commend."
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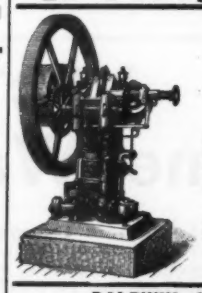

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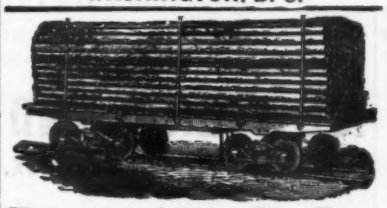

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TESTIMONIALS.
Western Edison Light Co., H. WARD LEONARD, General Sup't.
W. J. Buckley, Mgr. Ft. Wayne Jenny El. Light Co.
Thomson-Houston Electric Light, Herbert Wadsworth, Manager Western Office.
Brush Electric Co., Alex. Kempt, Special Agent.
Excelsior Electric Co., C. J. Reilly, Western Mgr.
Sperry Electric Light Motor & Car Brake Co., 901 Royal Insurance Building.
J. H. Reid, General Manager of the Mather Electric Light Co., Chicago.
Wm. H. Purdey, Comm. of Public Works, Chicago.
John Mab, Chief Engin'r of Board of Trade, Chic.
C. J. Melmes, Gen'l Sup't Thomson-Houston Light, Omaha, Neb.
J. A. Corbey, St. Joe Electric Light and Power Co., St. Joe, Mo.
Wm. Oswald, Agt. Edison Light Co., New Orleans, La.

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Our Belting is made of leather tanned on the surface only; the interior (which is the fiber and strength of the hide) is not tanned but rawhide fulled and softened by our patent process Our Belting is more pliable, hugs the pulley better, transmits more power than any other, and is the only perfect ELECTRIC LIGHT BELT MADE. Agents in all cities. Send for trial belt.

THE CAMPBELL LINE WIRE
FOR ELECTRIC LIGHTING.
A SUBSTITUTE FOR UNDERWRITER WIRE. A DURABLE, WELL INSULATED AND A FIRE AND WATER PROOF W RE.

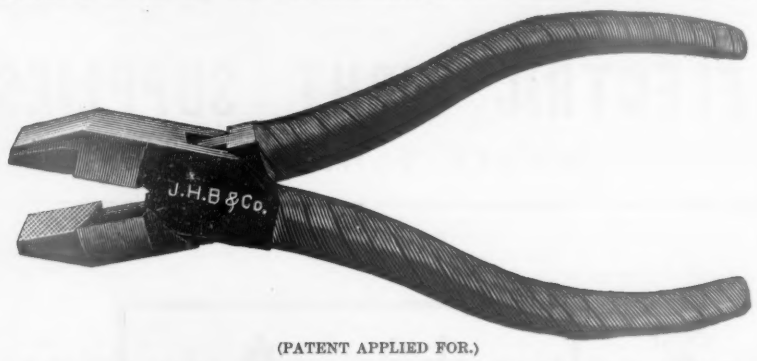
NOTICE.

WHEREAS, a falsifying circular, headed "Warning," has been issued by Messrs. Morss & Whyte and the Simplex Electrical Company, with a purport of injuring the NEW CAMPBELL LINE WIRE, we desire to call the attention of the public to the fact that this wire was designed by Mr. Henry F. Campbell, as was also the Campbell T. Z. R. Wire, and that we are the owners of both, the former being manufactured and sold only by us, while the latter has been manufactured under contract by Messrs. Morss & Whyte; but they having repeatedly broken said contract, we have already instituted legal proceedings against them to restrain them from the further manufacture of same.

We would further state that the Simplex Electrical Company, having tried in vain to secure the agency of our New Line Wire, now adopt the measures they have taken with the apparent intention of discouraging its use.

Yours Respectfully,
THE CAMPBELL ELECTRICAL SUPPLY COMPANY,
95 Milk Street, Boston.
HENRY F. CAMPBELL, Pres. *F. E. CLARK, Sec'y and Treas.*

McLAUGHLIN'S
SAFETY PLIERS for LINEMEN.

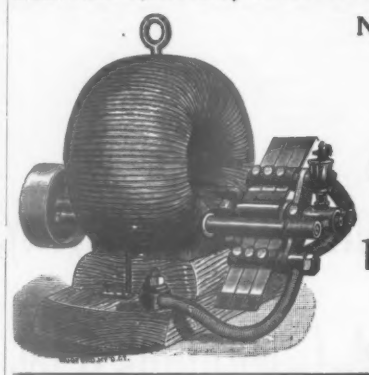


(PATENT APPLIED FOR.)

In order to prevent serious and often fatal accidents, such as have already occurred to linemen, in handling electric light wires, or telegraph and telephone wires and fire alarms, crossed with other wires carrying dangerously powerful currents, these pliers (which are the usual form and size of lineman pliers known as Stubs) are doubly covered and insulated on the handles with a good, strong and slightly elastic double coating of rubber and rubber tape so vulcanized both together that a uniform coating and thoroughly insulated protection is produced without in the least interfering with the efficiency or convenience in handling the pliers. Other sizes, office pliers, pocket pliers, for inside use where there is any liability to contact with powerful or dangerous currents will be soon ready for sale, all at prices but little in advance of usual figures for uninsulated pliers.

OWNED AND MANUFACTURED BY
J.H. BUNNELL & CO.
106 and 108 LIBERTY STREET, NEW YORK.
MANUFACTURERS of ELECTRICAL SUPPLIES

The Mather Dynamo-Electric Machine,
FOR
ELECTRO-PLATING, ELECTROTYPING, COPPER REFINING, ETC.



NO REVERSING,
NO WATER,
NO NOISE,
NO SPARK.

SATISFACTION GUARANTEED.

Manufactured by
The Eddy Electric Mfg. Co.
42 UNION PLACE, Opposite the Station,
HARTFORD, CONN.
SEND FOR CIRCULAR.

NEW YORK INSULATED WIRE CO.,
SOLE MANUFACTURERS OF THE
GRIMSHAW PATENT WHITE CORE
WIRES, CABLES AND TAPE,
BOSTON OFFICE: 11 Central St., Boston, Mass. - - SALESROOM: 452 Broadway, N. Y.
R. E. GALLAHER, Sec. W. B. DOWSE, Gen'l Supt. J. W. GODFREY, Gen'l Manager.

VICTOR
Turbine Water Wheel.

The attention of **Electric Companies** is called to this **celebrated water wheel** as particularly adapted to their use, on account of its **remarkably steady motion, high speed** and **great efficiency,** and **large capacity** for its **diameter,** being **double** the **power** of most **wheels** of **same diameter.** It is used by a number of the leading electric companies with great satisfaction. In the economical use of water it is without an equal, producing the highest per cent. of useful effect, **guaranteed.**

Our Horizontal "Victor" is highly recommended, as no gears are required, and it can be belted directly to Dynamo.

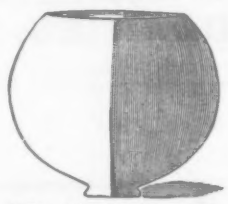
SEND FOR CATALOGUE AND PARTICULARS.
STILWELL & BIERCE MFG. CO.,
DAYTON, OHIO.
(Please Mention this Paper.)

NEW ENGLAND GLASS WORKS,
29 MURRAY ST., NEW YORK. 155 FRANKLIN ST., BOSTON.

10 In.—Roughed all over

10 In.—Opal.

9 In.—⅓ Horizontal Roughed.


12 In.—⅓ Vertical Roughed.

14 In—Clear Flint.

WE MAKE A SPECIALTY
OF
ELECTRIC GLOBES,
OF ALL SHAPES, IN
Clear, Roughed, or Opal Glass.
Our Facilities Enable us to Offer Special Inducements in
QUALITY AND PRICE.

W.L.LIBBEY & SON,
BOSTON, MASS.
SEND FOR PRICES.

Committee on Wire Gauge:

ALLAN V. GARRATT,
M. M. M. SLATTERY,
HERBERT H. EUSTIS,
OTTO A. MOSES,
H. D. STANLEY,
P. KEILHOLTZ.

National Electric Ligh

IN

CONVENTI

AT

Boston, - - - Augu

In pursuance of the vote of the Convention, held at Philadelphia, i
Metric Wire Gauge are respectfully submitted.

1	2	3	4	5	6	7	8	9	10	11
Gauge No.	Diameter.		Sectional Area.		Weight per Length.		Length per Weight.		Resistance in L 0°	
									Ohms per Length.	
N	Millimeters.	Inches.	Sq. Millimeters.	Sq. Inch.	Kilogr'mes per Kilometer.	Pds. per 1000 ft.	Kilometers per Kilogramme.	Feet per Pound.	Ohms per Kilometer.	Ohms Per 1000
1	.1	.0039	.0079	.00001	.0699	.04692	14.306	21313.	2034.2	620.000
2	.2	.0079	.0314	.00005	.2796	.18767	3.5765	5328.5	508.23	154.900
3	.3	.0118	.0707	.00011	.6291	.42226	1.5896	2368.2	226.02	68.889
4	.4	.0157	.1257	.00019	1.1184	.75069	.89413	1332.1	127.14	38.750
5	.5	.0197	.1963	.00030	1.7475	1.1730	.57224	852.55	81.367	24 800
6	.6	.0236	.2827	.00044	2.5164	1.6891	.39739	592.05	56.504	17.222
7	.7	.0276	.3848	.00060	3.4251	2.2990	.29196	434.97	41.514	12.653
8	.8	.0315	.5027	.00078	4.4736	3.0028	.22353	333.05	31.784	9.687
9	.9	.0354	.6362	.00099	5.6619	3.8004	.17662	263.13	25.113	7.619
10	1.0	.0394	.7854	.00122	6.9900	4.6918	.14306	213.14	20.342	6.200
11	1.1	.0433	.9503	.00147	8.4580	5.6771	.11823	176.15	16.811	5.124
12	1.2	.0472	1.1310	.00175	10.066	6.7562	.099348	148.01	14 126	4.305
13	1.3	.0512	1.3273	.00206	11.813	7.9292	.084651	126.11	12.036	3.668
14	1.4	.0551	1.5394	.00239	13.700	9.1960	.072990	108.74	10.378	3.163
15	1.5	.0591	1.7671	.00274	15.728	10.557	.063582	94.727	9.0407	2.755
16	1.6	.0630	2.0106	.00312	17.895	12.011	.055883	83.257	7.9460	2.421
17	1.7	.0669	2.2698	.00352	20.201	13.559	.049502	75.580	7.0386	2.145
18	1.8	.0709	2.5447	.00394	22.648	15.201	.044155	65.783	6.2783	1.913
19	1.9	.0748	2.8353	.00439	25.234	16.937	.039629	59.041	5.6348	1.714
20	2.0	.0787	3.1416	.00487	27.960	18.767	.035765	53.284	5.0854	1.550
21	2.1	.0827	3.4636	.00537	30.826	20.691	.032440	48.330	4.6126	1.405
22	2.2	.0866	3.8013	.00589	33.832	22.708	.029558	44.037	4.2028	1.281
23	2.3	.0906	4.1548	.00644	36.977	24.820	.027044	40.291	3.8453	1.172
24	2.4	.0945	4.5239	.00701	40.263	27.025	.024837	37.003	3.5315	1.076
25	2.5	.0984	4.9087	.00761	43.688	29.324	.022890	34.102	3.2547	.992
26	2.6	.1024	5.3093	.00823	47.253	31.717	.021163	31.529	3.0091	.917
27	2.7	.1063	5.7256	.00875	50.957	34.203	.019624	29.237	2.7904	.850
28	2.8	.1102	6.1575	.00954	54.802	36.784	.018248	27.186	2.5946	.790
29	2.9	.1142	6.6052	.01024	58 786	39.458	.017011	25.343	2.4188	.737
30	3.0	.1181	7.0686	.01096	62.910	42.129	.015896	23.682	2.2550	.687
31	3.1	.1220	7.5477	.01171	67.174	45.088	.014887	22.179	2.1167	.645
32	3.2	.1260	8.0425	.01247	71.578	48.044	.013971	20.814	1.9865	.605
33	3.3	.1299	8.5530	.01326	76.122	51.094	.013137	19.572	1.8679	.569
34	3.4	.1339	9.0792	.01407	80.805	54.237	.012375	18.437	1.7597	.536
35	3.5	.1378	9.6211	.01491	85.628	57.475	.011678	17.399	1.6605	.506
36	3.6	.1417	10.1788	.01578	90.591	60.806	.011039	16.446	1.5696	.476
37	3.7	.1457	10.7521	.01667	95.694	64.231	.010451	15.569	1.4859	.452
38	3.8	.1496	11.3412	.01758	100.94	67.750	.009907	14.760	1.4087	.429
39	3.9	.1535	11.9459	.01852	106.32	71.363	.009406	14.013	1.3374	.407
40	4.0	.1575	12.5664	.01948	111.84	75.069	.008941	13.321	1.2714	.387
41	4.1	.1614	13.2025	.02046	117.50	78.870	.008510	12.679	1.2101	.368
42	4.2	.1654	13.8544	.02148	123.30	82.764	.008110	12.083	1.1532	.351
43	4.3	.1693	14.5220	.02251	129.24	86.752	.007737	11.527	1.1001	.336
44	4.4	.1732	15.2053	.02357	135 33	90.834	.007390	11.009	1.0507	.320
45	4.5	.1772	15.9043	.02466	141.55	95.009	.007065	10.525	1.0045	.306
46	4.6	.1811	16.6190	.02576	147.91	99.279	.006761	10.073	.96133	.293
47	4.7	.1850	17.3494	.02689	154.41	103.88	.006476	9.6264	.92085	.280
48	4.8	.1890	18.0956	.02805	161.05	108.10	.006209	9.2507	.88289	.269
49	4.9	.1929	18.8574	.02923	167.83	112.65	.005958	8.8770	.84722	.258
50	5.0	.1969	19.6350	.03044	174.75	117.30	.005722	8.5255	.81367	.248
51	5.1	.2008	20.4282	.03166	181.81	122.03	.005500	8.2044	.78207	.238
52	5.2	.2047	21.2372	.03292	189.01	126.87	.005291	7.3823	.75055	.228
53	5.3	.2087	22.0618	.03420	196.35	131.79	.005093	7.5876	.72416	.220
54	5.4	.2126	22.9022	.03500	203.83	136.81	.004917	7.3092	.69759	.212
55	5.5	.2165	23.7583	.03683	211.45	141.93	.004729	7.0458	.67245	.204
56	5.6	.2205	24.6301	.03818	219.21	147.14	.004562	6.7965	.64865	.197
57	5.7	.2244	25.5176	.03955	227.11	152.44	.004403	6.5601	.62609	.190
58	5.8	.2284	26.4208	.04095	235.14	157.83	.004253	6.3358	.60489	.184
59	5.9	.2323	27.3397	.04238	243.32	163.32	.004110	6.1229	.58436	.178
60	6.0	.2362	28.2743	.04382	251.64	168.91	.003974	5.9205	.56505	.172
61	6.1	.2402	29.2247	.04530	260.10	174.58	.003845	5.7279	54667	.166
62	6.2	.2441	30.1907	.04680	268.70	180.35	.003722	5.5447	.52918	.161
63	6.3	.2480	31.1725	.04832	277.43	186.22	.003605	5.3700	.51251	.156
64	6.4	.2520	32.1699	.04987	286.31	192.17	.003493	5.2035	.49662	.151
65	6.5	.2559	33.1831	.05144	295.33	198.23	.003386	5.0447	.48146	.146
66	6.6	.2598	34.2120	.05303	304.49	204.38	.003284	4.8929	.46698	.142
67	6.7	.2638	35.2565	.05465	313.78	210.62	.003187	4.7480	.45314	.138
68	6.8	.2677	36.3168	.05629	323.22	216.95	.003087	4.6094	.43992	.134
69	6.9	.2717	37.3930	.05796	332.80	223.38	.003005	4.4767	.42726	.130
70	7.0	.2756	38.4845	.05965	342.51	229.90	.002920	4.3497	.41514	.126
71	7.1	.2795	39.5928	.06136	352.37	236.51	.002838	4.2281	.40352	.122
72	7.2	.2835	40.7150	.06311	362.36	243.22	.002760	4.1115	.39239	.119
73	7.3	.2874	41.8539	.06488	372.50	250.03	.002685	3.9996	.38172	.116
74	7.4	.2913	43.0085	.06667	382.78	256.92	.002613	3.8922	.37138	.113
75	7.5	.2953	44.1786	.06849	393.19	263.92	.002545	3.7891	.36163	.110
76	7.6	.2992	45.3646	.07032	403.74	271.00	.002477	3.6900	.35218	.107
77	7.7	.3032	46.5663	.07218	414.44	278.18	.002413	3.5948	.34309	.104
78	7.8	.3071	47.7836	.07407	425.27	285.45	.002351	3.5032	.33435	.101
79	7.9	.3110	49.0167	.07598	436.25	292.82	.002292	3.4151	.32594	.099
80	8.0	.3150	50.2655	.07792	447.36	300.28	.002235	3.3303	.31784	.096
81	8.1	.3189	51.5300	.07988	458.62	307.83	.002181	3.2485	.31004	.094
82	8.2	.3228	52.8102	.08186	470.01	315.48	.002128	3.1698	.30252	.092
83	8.3	.3268	54.1061	.08387	481.54	323.22	.002077	3.0939	.29528	.089
84	8.4	.3307	55.4177	.08590	493.22	331.06	.002028	3.0206	.28829	.087
85	8.5	.3347	56.7450	.08796	505.03	338.98	.001980	2.9500	.28155	.085
86	8.6	.3386	58.0881	.09004	516.98	347.01	.001934	2.8818	.27504	.083
87	8.7	.3425	59.4468	.09215	529.08	355.12	.001890	2.8159	.26875	.081
88	8.8	.3465	60.8212	.09428	541.31	363.33	.001847	2.7523	.26268	.080
89	8.9	.3504	62.2114	.09643	533.68	371.64	.001806	2.6908	.25681	.078
90	9.0	.3543	63.6173	.09861	566.19	380.04	.001766	2.6313	.25113	.076
91	9.1	.3583	65.0388	.10082	578.85	388.53	.001728	2.5738	.24564	.074
92	9.2	.3622	66.4761	.10304	591.64	397.12	.001690	2.5182	.24033	.073
93	9.3	.3662	67.9291	.10530	604.57	405.80	.001654	2.4643	.23519	.071
94	9.4	.3701	69.3978	.10757	617.64	414.57	.001619	2.4121	.23021	.070
95	9.5	.3740	70.8822	.10987	630.85	423.44	.001585	2.3616	.22539	.068
96	9.6	.3780	72.3823	.11220	644.20	432.40	.001552	2.3127	.22072	.067
97	9.7	.3819	73.8981	.11455	657.69	441.45	.001521	2.2652	.21620	.065
98	9.8	.3858	75.4297	.11692	671.32	450.60	.001490	2.2193	.21180	.064
99	9.9	.3898	76.9769	.11932	685.09	459.85	.001460	2.1746	.20755	.063
100	10.	.3937	78.5398	.12174	699.00	469.18	.001431	2.1314	.20342	.062

Entered according to the Act of Congress, in the Office of the Librarian of Co

ght Association,

TION,

gust 9th, 1887.

Calculations made by

ALLAN V. GARRATT,
HERBERT H. EUSTIS,
P. KEILHOLTZ.

, in February, 1887, the following mathematical properties of the

ALLAN V. GARRATT, Chairman.

11	12	13	14	15	16	17	18
in Legal Ohms Pure Copper, at 0° Centigrade.			Logarithms of Sectional Area.		Square.	Nearest Corresponding Number.	
gth.	Length per Ohms.						
Ohms 1000 Feet.	Kilometers per Ohm.	Feet per Ohm.	Log. Sq. millimeters.	Log. Sq. Inch.	Square of Gauge Number.	In Brown & Sharp Gauge.	In Birmingham Gauge.
20.000	.00049	1.6129	-3.8950899	-5.0854427	1	38	36
54.900	.00197	6.4556	-2.4971499	-5.6875027	4	32	33
58.889	.00442	14.516	-2.8493325	-4.0396853	9	29	30
38.750	.00787	25.806	-1.0992099	-4.2895517	16	26	27
24 800	.01229	40.323	-1.2930299	-4.4833827	25	24	25
17.222	.01770	58.065	-1.4513925	-4.6417453	36	23	24
12.653	.02409	79.032	-1.5852859	-4.7756673	49	21	22
9.6875	.03146	103.22	-1.7012699	-4.8916227	64	20	21
7.6191	.03982	131.25	-1.8035749	-4.9939083	81	19	20
6.2000	.04916	161.29	-1.8950899	-3.0854427	100	18	19
5.1240	.05551	195.16	-1.9778753	-3.1682281	121	17	19
4.3055	.07079	232.26	0.0534525	-3.2438051	144	17	18
3.6687	.08308	272.58	0.1229767	-3.3133297	169	16	18
3.1633	.09635	316.13	0.1873459	-3.3776991	196	15	17
2.7556	.11061	362.90	0.2472725	-3.4376385	225	15	17
2.4219	.12585	412.90	0.3033299	-3.4936827	256	14	16
2.1454	.14207	466.13	0.3559877	-3.5463405	289	14	16
1.9136	.15928	522.58	0.4056349	-3.5959877	324	13	15
1.7143	.17747	583.32	0.4525971	-3.6429615	361	13	15
1.5500	.19664	645.16	0.4971499	-3.6875027	400	12	14
1.4059	.21680	711.29	0.5395285	-3.7298815	441	12	14
1.2810	.23794	780.65	0.5799353	-3.7702881	484	11	14
1.1720	.26006	853.23	0.6185455	-3.8089073	529	11	13
1.0764	.28316	929.03	0.6555123	-3.8458653	576	11	13
.99200	.30725	1008.1	0.6909699	-3.8813229	625	10	12
.91716	.33232	1090.3	0.7250367	-3.9153895	676	10	12
.85048	.35838	1176.6	0.7578175	-3.9481705	729	10	12
.79082	.38542	1294.0	0.7894059	-3.9797589	784	9	12
.73722	.41344	1356.5	0.8198859	-2.0102387	841	9	12
.68730	.44346	1453.3	0.8493325	-2.0396853	900	9	11
.64516	.47243	1550.0	0.8778133	-2.0681633	961	8	11
.60547	.50340	1651.2	0.9053899	-2.0957427	1024	8	11
.56933	.53535	1756.5	0.9321177	-2.1224707	1089	8	10
.53633	.56829	1868.8	0.9580477	-2.1484007	1156	8	10
.50612	.60221	1975.8	0.9832259	-2.1735789	1225	7	10
.47620	.63712	2100.0	1.0076949	-2.1980479	1296	7	10
.45289	.67300	2208.1	1.0314933	-2.2218461	1369	7	9
.42936	.70987	2329.0	1.0546571	-2.2450101	1444	7	9
.40763	.74773	2453.2	1.0772191	-2.2675721	1521	6	9
.38750	.78656	2580.7	1.0992099	-2.2895627	1600	6	9
.36833	.82638	2711.3	1.1206577	-2.3110105	1681	6	8
.35147	.86719	2845.2	1.1415885	-2.3319413	1764	6	8
.33609	.90897	2982.3	1.1620269	-2.3523757	1849	6	8
.32025	.95174	3122.6	1.1819953	-2.3723481	1936	5	8
.30617	.99549	3266.1	1.2015149	-2.3918679	2025	5	7
.29300	1.0402	3412.9	1.2206055	-2.4109583	2116	5	7
.28067	1.0859	3562.9	1.2392857	-2.4296385	2209	5	7
.26910	1.1327	3716.1	1.2575723	-2.4479251	2304	5	7
.25822	1.1803	3872.6	1.2754821	-2.4658351	2401	5	6
.24800	1.2290	4032.3	1.2930299	-2.4833829	2500	4	6
.23837	1.2787	4195.2	1.3102303	-2.5005831	2601	4	6
.22876	1.3324	4371.3	1.3270965	-2.5174495	2704	4	6
.22072	1.3809	4530.7	1.3436417	-2.5339945	2809	4	6
.21262	1.4335	4703.2	1.3598775	-2.5502253	2916	4	5
.20496	1.4871	4879.1	1.3758153	-3.5661681	3025	4	5
.19770	1.5417	5058.1	1.3914659	-2.5818187	3136	3	5
.19083	1.5972	5240.3	1.4068397	-2.5971923	3249	3	5
.18430	1.6537	5425.8	1.4219459	-2.6122987	3364	3	5
.17811	1.7113	5614.5	1.4367939	-2.6271467	3481	3	4
.17222	1.7697	5806.5	1.4513925	-2.6417441	3600	3	4
.16641	1.8292	6001.6	1.4657495	-2.6561025	3721	3	4
.16129	1.8897	6200.0	1.4798733	-2.6702263	3844	3	4
.15621	1.9512	6401.6	1.4937711	-2.6841239	3969	2	4
.15137	2.0136	6606.5	1.5074499	-2.6978027	4096	2	3
.14675	2.0770	6814.5	1.5209167	-2.7112659	4225	2	3
.14233	2.1414	7025.8	1.5341777	-2.7245307	4356	2	3
.13812	2.2068	7240.3	1.5472395	-2.7375925	4489	2	3
.13408	2.2732	7458.1	1.5601077	-2.7504607	4624	2	3
.13023	2.3405	7679.0	1.5727881	-2.7631413	4761	2	3
.12653	2.4088	7903.2	1.5852859	-2.7756389	4900	1	2
.12299	2.4782	8130.7	1.5976067	-2.7879595	5041	1	2
.11960	2.5485	8361.3	1.6097549	-2.8001077	5184	1	2
.11634	2.6197	8595.2	1.6217357	-2.8120885	5329	1	2
.11320	2.6926	8834.3	1.6335533	-2.8239061	5476	1	2
.11022	2.7653	9072.6	1.6452125	-2.8355653	5625	1	1
.10734	2.8395	9316.1	1.6567171	-2.8470699	5776	1	
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.09678	3.1463	10322.	1.7012639	-2.8916227	6400	0	1
.09450	3.2254	10582.	1.7120599	-2.9024129	6561	0	1
.09221	3.3055	10845.	1.7227177	-2.9130705	6724	0	0
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.08787	3.4687	11381.	1.7436485	-2.9340015	7056	0	0
.08581	3.5518	11653.	1.7539277	-2.9442777	7225	0	0
.08383	3.6359	11929.	1.7640869	-2.9544291	7396	0	0
.08191	3.7209	12208.	1.7741285	-2.9644813	7569	0	0
.08006	3.8070	12490.	1.7840553	-2.9744081	7744	00	0
.07827	3.8940	12776.	1.7938699	-2.9842185	7921	00	0
.07654	3.9820	13065.	1.8035749	-2.9939279	8100	00	0
.07487	4.0710	13357.	1.8131727	-1.0035257	8281	00	0
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.07170	4.2519	13950.	1.8320559	-1.0224085	8649	00	00
.07017	4.3438	14252.	1.8413457	-1.0316985	8836	00	00
.06870	4.4367	14556.	1.8505371	-1.0408897	9025	00	00
.06727	4.5306	14865.	1.8596323	-1.0499851	9216	00	00
.06589	4.6255	15176.	1.8686333	-1.0589863	9409	00	00
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.06200	4.9160	16129.	1.8950899	-1.0854427	10000	000	00